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# RECORDS

OF THE

# GEOLOGICAL SURVEY OF VICTORIA

(H. HERMAN, B.C.E., M.M.E., F.G.S., Director.)

Vol. III., Part 4.

# CAINOZOIC GEOLOGY OF THE MALLEE AND OTHER VICTORIAN BORES.

BY

FREDERICK CHAPMAN, A.L.S., F.R.M.S.,

Palæontologist to the National Museum, Melbourne.

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# PREFATORY NOTE.

This report is the result of patient and systematic palæontological investigation extending over a period of several years. It has required the sacrifice of much private time that might well have been devoted to rest from the arduous routine of Mr. Chapman's ordinary official duties. The scientific results are a valuable addition to Australian palæontology and the little known geology of the north-west Mallee. Eleven bores have been closely studied, and in every case it has been found that a polyzoal rock series of Miocene age was reached before fresh water was obtained; this demonstration should be an important practical guide to future water boring operations over many thousands of square miles of the Lower Murray region in South Australia, New South Wales, and Victoria. The cores of a much larger number of Mallee bores still await examination, but there is unfortunately no immediate prospect of Mr. Chapman being able to continue his important researches on this material.

Mr. A. S. Kenyon, C.E., as Engineer for the State Rivers and Water Supply Commission, directed the water boring. Mr. Chapman's researches were undertaken by permission of the Director of the National Museum. Mr. Kenyon has saved and classified the cores throughout the operations of several years, and it is due to his appreciation of the importance of the work and care in collecting data that Mr. Chapman's investigations have been made possible.

H. HERMAN,
Director of Geological Survey.

29/11/15.

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# CAINOZOIC GEOLOGY OF THE MALLEE AND OTHER VICTORIAN BORES.

By Frederick Chapman, A.L.S., F.R.M.S., Palæontologist to the National Museum, Melbourne.

## 1. INTRODUCTION.

The Tertiary or Cainozoic deposits of Southern Australia have presented many problems to the stratigraphical geologist in regard to the true succession of the beds and their vertical extent. These matters can only be solved satisfactorily by an exhaustive examination of the material brought up from various depths at given localities by means of deep boring. The present opportunity of studying one of the most extensive series of borings yet made in the Victorian Tertiary beds at any locality was therefore hailed with satisfaction, when the work of testing for water-bearing strata in the Mallee was undertaken by the Agricultural Department of Victoria.

The collection and preservation of material from each of the bores here dealt with was superintended by Mr. A. S. Kenyon, C.E., Engineer State Rivers and Water Supply Commission, who, with Mr. J. J. Scarce, the foreman in charge of the borings, deserves credit for the care in conserving the data regarding depths, without which the results embodied in this report would have lost considerable value.

The ancient geological and geographical features of this area of the Mallee district in Tertiary times will be dealt with more fully in Sections 7 and 8 of this report. Suffice it here to say that the underground geology of this part of the country proves the existence in Middle Tertiary times of a great gulf of the Southern Ocean, which was bounded on the west by the Palæozoic axis of which the Mount Lofty ranges forms a part, and was probably continuous with the Miocene sea of the Mount Gambier district. The latter point is clearly borne out by the similarity of the fossil faunas of both areas, as shown in this report. This inland sea was partially enclosed by an intermittent barrier of metamorphic rocks, remnants of which appear at the present time in a line between Casterton and Murray Bridge. This Murray gulf was separated from another marine area to the south-east by the Dundas and Grampian ranges, which then formed a short truncated peninsula directed to the south-west.[1] The Victorian portion of this old Southern Ocean sea-bed comprises the area situated between the Grampians and the present coast, and, indeed, extended far to the south. It took in the Tertiary districts of Hamilton, Hexham, Camperdown and Geelong, forming a wide strait passing north of the Otway Jurassic island as far as the eastern boundary of what is now Port Phillip Bay. This inland sea was co-extensive with Gregory's Great Valley of Victoria.[2] The Middle Tertiary sea trended southerly towards Cape Schanck and Flinders, whilst the Jurassic island of South Gippsland was but imperfectly cut off from the mainland on the north by swamps and lagoons giving rise, in all probability, to deposits of lignite. Along its northern boundary this Tertiary sea swept to the north-east, across what is now the lake district of south-east Gippsland. Evidence of marine conditions in this locality has been lately revealed in the Paynesville bore near Bairnsdale.

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[1] See fig. 41, p. 406.

[2] Gregory, J. W. Geography of Victoria, revised ed.. 1912, pp. 84 and 87. See also pp. 124, 125 for engrafting of the rivers of the Murravian basin.

The sediments laid down in Middle Tertiary times to the north of the "Primitive Mountain Chain"[1] formed the foundation of the vast area occupied at the present day by the basins of the Wimmera, Murray, Darling, Murrumbidgee and Lachlan Rivers. The features of this large subterranean catchment area were clearly summarized by Reginald Murray in his Report on Artesian Well-boring in the Wimmera District, furnished to the Geological Survey in 1882.[2] He there pointed out that the Wimmera area is the natural outlet for the vast quantity of subterranean water which must continually flow down to the sea from the upper reaches of the Murray basin, since the hard foundation rocks of Palæozoic metamorphic schists at the base of the Grampians on the Victorian, and similar rocks on the South Australian, side of the Murray forming the Mount Lofty and Mount Barker ranges, are the portals through which this vast underground river must flow.

## 2. POSITIONS OF THE BORES.

The bores systematically dealt with in this report are situated in the Mallee, to the north of that area generally known as the Wimmera district, and are all in the county of Weeah. (See Fig. 39.) They commence at about 6 miles east of the South Australian boundary near Pinaroo, and 50 miles north of the 36th parallel. They are continued in a line due eastward from Kow Plains at distances of 2 to 4 miles apart. The water in these borings has been met with at 170–250 feet from the surface, and in most cases has risen to within 10–70 feet of the surface.

The bores are numbered from 1 to 11, in regard to the samples examined. A further series of borings, however, has been made in the same district of the Mallee, but the material from these has been held over for want of time to devote to its examination. Moreover, a detailed inspection of the succeeding bores would in all probability add very little to the interesting results already gained, which it is hoped will form an introduction to the scientific study of the borings in this area.

## 3. METHODS OF BORING.

The samples of rock from the various depths in the borings were taken at reasonably short intervals.

The boring was effected by a Victoria percussion drill. The softer strata were penetrated by the ordinary twist bit or shell auger. Casing was used to prevent the sides of the bore falling in, but this was not put down immediately the depth was lowered; sometimes there being as much as 60 feet uncased at a time. In this way there was obviously some risk of admixture of samples taking place within limits of distance corresponding with the uncased portion of the bore-hole.

For the harder portion of the strata, such as limestone and indurated sandrock, the chisel or star-bit was used. Since the fossils in this kind of material were never of large size, nor easily obtained by disintegration in water, the good results were not lessened by this rough means of extraction.

Considering the methods of obtaining the material generally, the results were surprisingly satisfactory. For instance, large numbers of moderate-sized fossil shells, as *Glycimeris*, *Leda*, *Limopsis*, *Venus*, *Meretrix*, *Natica*, *Turritella* and *Tylospira*, and also fossil sea-urchins as *Scutellina* and *Psammechinus*, were obtained in perfect condition from the sandy and shelly clays; and further, the smaller mollusca and minute organisms, as ostracoda and foraminifera, were found in great profusion on washing, sifting and sorting the material.

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[1] Gregory, J. W. Geography of Victoria, revised ed., 1912, pp. 75 and 76.
[2] Prog. Rep. Geol. Surv. Vict., Vol. VII., 1884, pp. 96–100.

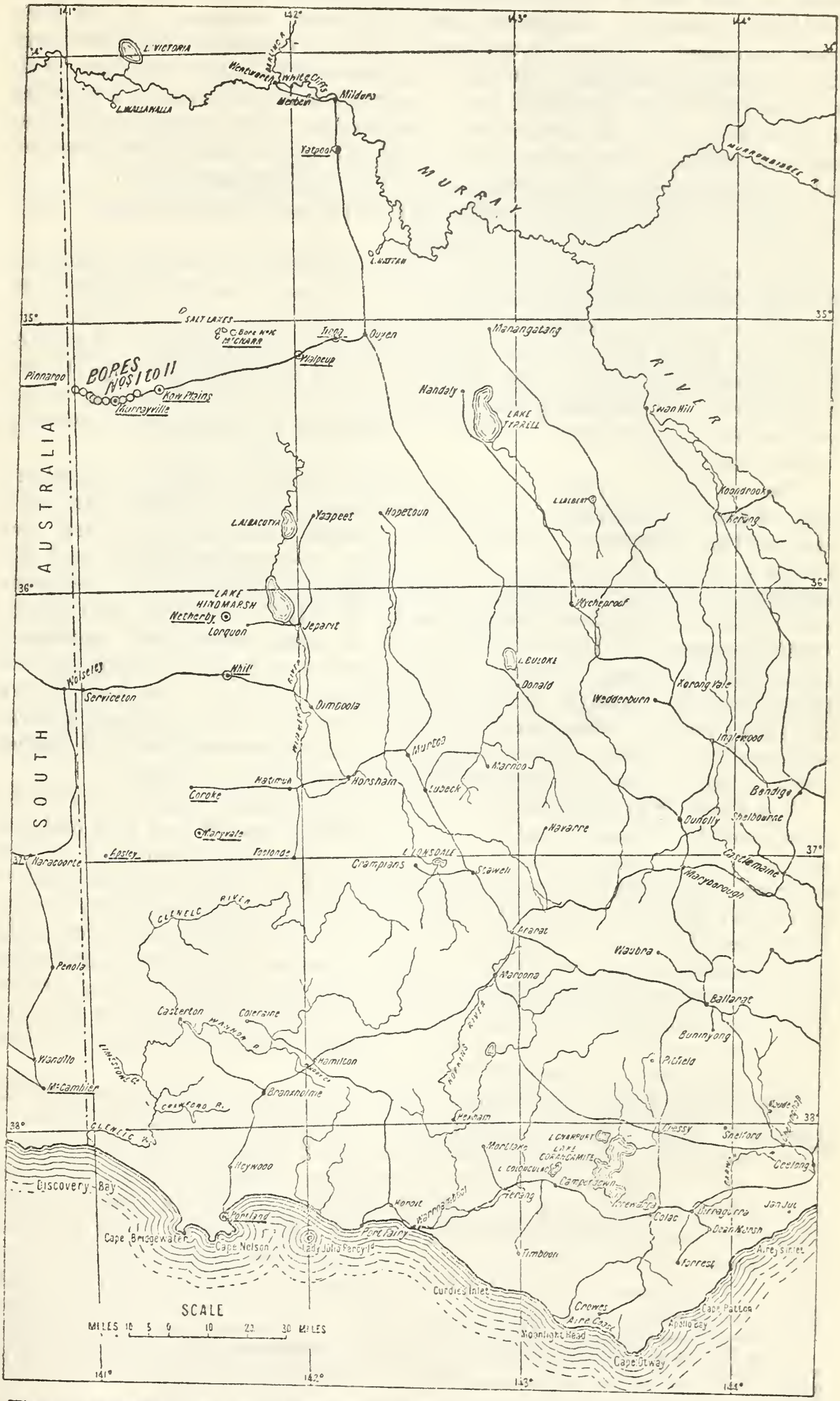


Fig. 39. Locality map showing positions of bores and places mentioned in this report.

After the writer had spent some time on the samples he found that, to obtain a good idea of the full extent of the Tertiary beds in this locality, it would be necessary to deepen a bore; but since re-opening an old bore would have been a matter of great expense, it was arranged that the last bore, then in operation, should be carried to a greater depth. This was done, with the final result that operations had to be suspended on reaching a stratum of black flint; but not before the comparatively great depth of 600 feet had been reached. The last stratum met with, being of a hard, cherty nature, had a serious effect on the connecting rods of the percussion drill.[1]

## 4. NOTES ON THE TREATMENT OF THE MATERIAL FROM THE BORES.

The first batch of material was sent to the National Museum from the Hon. the Minister for Agriculture (per Mr. A. S. Kenyon) on 26th August, 1908. The work of washing, sorting and determining specimens, and of describing the material in detail, has occupied a large proportion of my official and private time during these past six years; and I would here take the opportunity of expressing my thanks to Mr. C. J. Gabriel for his valuable collaborative work on the mollusca, and to Mr. R. A. Keble of the Geological Survey for general assistance.

The samples as received were all carefully packed in tins or boxes, so that no risk of admixture in transit could occur. The superficial deposits, such as the Pleistocene sands, were examined both in the natural and washed condition, by means of low and high power magnification, and the characters of each sample noted. The superficial and concretionary limestones were sliced and examined microscopically, in order to ascertain their origin, whether organic or chemical. The estuarine muds beneath the superficial accumulations of sand and gravel were carefully washed, and both the fine and the coarser material examined for organic remains. The foraminifera and echinus spines, being usually so minute, were found in the finest of these washings; the former represented by starved or dwarfed shells of species which attain larger dimensions when in purer marine habitats.

The shelly clays, greensands and muds of the Kalimnan series downwards, were carefully washed; and in the case of small samples no fine material was allowed to escape before being examined. Several samples of the borings were obtained in such large quantity[2] that the main portion had to be washed through a sieve of 40 meshes to the lineal inch; a smaller portion being treated for finer washings, which invariably contained examples of the minute crustacea and foraminifera. The microzoa last-named, which often gave interesting data as to depth of sea-bottom when living, as well as climatic and other conditions, were generally found in siftings between the 40 to 90 to an inch mesh. The mollusca were generally obtained in siftings retained by the sieve having a mesh of 90 to the inch.

To prevent injury to the most delicate shells by undue trituration, the process of washing these fossiliferous sediments was conducted as follows:— The lumps of clay, &c., after being slowly dried, were dropped into a dish of water and allowed to disintegrate thoroughly. The soft material was then poured into a deep basin and rapidly swirled, and after a lapse of about 30 seconds the suspended mud was poured off; then swirled round with very little water, and again filled with water and the suspended matter poured away. This process was repeated until the residuum consisted mainly of shells and comminuted rock or sand-grains, when the material was dried and sifted.

[1] The foreman in charge, Mr. Scarce, writes under date 29th August, 1909:—"The jar on the rods when jumping at that depth (600 feet) is very severe, and you run a big risk of breaking them; as it was we bent nine of our rods the last time we had them down. It would need a diamond drill to get past the 600 feet."

[2] For example, Bore No. 6 at 114-150 feet was represented by about half a hundredweight of blue clay with shells. All the coarse material from this sample was sorted, and the fossiliferous contents identified; the finer material being examined in much smaller quantity, an ounce or so of the washings sufficing to give an average idea of the character of the included microzoa.

# 5.—DETAILS OF BORES Nos. 1 TO 11, WITH THE FOSSILS OBTAINED THEREFROM.

## BORE No. 1.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| Surface–3 | A fine, dark-brown, loamy sand | Contains numerous vegetable fibres. Sand composed of sub-angular to moderately well-rounded quartz grains, with a few chalcedonic and ferruginous (hæmatitic) grains. Roughly speaking, less than 1 per cent. of the quartz grains are wind-polished, and those only of the smaller particles. |
| 3–10 .. | A pale-brown, rubbly, steatitic clay with a little sand | Breaks down in water to a fine deposit like fuller's earth. Under the microscope the ultimate disintegrated particles resemble irregular flakes of steatite. |
| 10–24 .. | A pale-brown, steatitic clay similar to the above, but closer in texture | Cuts with a bright surface. |
| 24–30 .. | White steatitic clay. Adhesion to moist surface very strong | Containing a few angular quartz grains of small dimensions, averaging 0·2 mm. in diameter. |
| 30–41 .. | A white, soapy clay (steatitic), more friable than the last | The fine washings under the microscope show this sample to contain a fair proportion of fine quartz sand. |
| 41–46 .. | Bright-yellow sand .. | The ochreous coating of the quartz grains is readily washed off in water. The quartz grains are sub-angular to rounded; a small proportion wind-polished. A few limonitic fragments present. |
| 46–60 .. | Whitish quartz sand .. | Sub-angular quartz grains, with very little polishing. |
| 60–67 .. | Fine, white, quartz sand, with a few larger grains; also some felspathic particles | Angular to sub-angular grains. |
| 67–70 .. | Fine, white, quartz sand, with a few larger grains of milky quartz and felspathic particles | Angular to sub-angular quartz grains. Associated with these are a few pink jasper and black (?) lydite particles. |
| 70–89 .. | Fine white sand composed largely of quartz, with many felspathic fragments and flakes of white mica (probably muscovite) | This is evidently a sand directly derived from granite. It also points to a similar origin for the three preceding samples. |
| 89–95 .. | A granitic sand in which the felspathic and micaceous fragments are fairly numerous. This, if consolidated, would be termed a true arkose | Also a few dark-green to black (?) lydite particles are present. The small hexagonal plates of mica seem to indicate a moderately fine-grained granite for the rock of its origin. |
| 95–101 .. | Fine sand of a pale-brown colour; containing, besides quartz, some felspathic fragments and mica | Some jasper particles present. |
| 101–140 .. | A fine pink sand, with a moderate proportion of mica flakes and some felspathic fragments | The quartz grains are perfectly angular. |
| 140–141 .. | Quartz pebbles measuring about 6 to 18 mm. in diameter | These are sub-angular to rounded, with the edges and surfaces smoothed, but not particularly well polished; probably water-worn. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 1—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 141–147 .. | Fragments of yellow to red ferruginous sandstone with a few micaceous particles | No traces of fossils. Small "clay-galls" of a reddish colour are not uncommon. |
| 147–151 .. | Yellow ferruginous sandstone containing some mica | Containing a doubtful impression of a polyzoan. |
| 151–154 .. | Hard yellow and brown ferruginous sandstone (micaceous) | No fossils. |
| 154–190 .. | A glauconitic clay full of shell-fragments | Comminuted shells in abundance; the fragments with rounded edges. They are bored in all directions by a parasitic organism, either a fungus or an alga. It will therefore be seen that this deposit was originally subjected to currents in denuded submarine areas.<br>Numerous glauconite grains are present, of a dark to pale apple-green colour. Especially minute specimens of foraminifera, of the following genera and species occur:—*Bolivina robusta*, Brady; *Anomalina ammonoides*, Rss. sp.; *Rotalia beccarii*, L. sp.; *R. clathrata*, Brady; *Polystomella crispa*, L. sp. Other fossil remains include an indeterminate fragment of an echinoid, a few rolled fragments of polyzoa, and an operculum of a gasteropod. |
| 190–192 .. | Hard yellow and brown ferruginous sandstone (micaceous) | No fossils met with. |
| 192–210 .. | A glauconitic clay full of shell-fragments | This sample contains an assemblage of foraminifera similar in character to that from 154 to 190 feet, and indicative of shallow water or estuarine conditions.<br>Foraminifera.—*Discorbina turbo*, d'Orb. sp.; *Truncatulina lobatula*, W. and J. sp.; *Rotalia beccarii*, L. sp.; *Polystomella crispa*, L. sp.; *P. macella*, F. and M. sp.<br>Mollusca.—Shell-fragments, much water-worn and impregnated with glauconite, are abundant, but generally too characterless to determine. *Glycimeris* sp., however, could be identified.<br>Crustacea.—A fragmentary plate of (?) *Balanus*.<br>Pisces.—A polished plate, probably from the dentary portion of a fish, such as *Diodon*; also otoliths of a teleostean fish. |
| 208–210 .. | In this sample at least two different lithological seams are mixed. There are pieces of earthy, calcareous, polyzoal rock, with frequent moulds of fossils; and also a series of Kalimnan fossils, carrying fragments of a sandy, glauconitic matrix | The fossils occurring in this sample are:—(?) *Clypeaster gippslandicus*, McCoy (a fragment); *Limopsis insolita*, G. Sow. sp.; *Glycimeris convexus*, Tate sp. (very common); *G. halli*, Pritchard; *Crassatellites kingicoloides*, Pritch.; *Corbula ephamilla*, Tate; *Natica substolida*, Tate.<br>In the polyzoal rock, impressions of *Orbitolites complanata*, Lam. and *Limatula jeffreysiana*, T. W. occur. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 1—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 210–212 .. | A cherty fossiliferous greensand | This sample contains shells of brachiopods and numerous foraminifera. Especially noteworthy amongst the latter is the large discoidal form, *Orbitolites complanata*, Lam.<br>A thin section of one of the rock-fragments shows it to consist of foraminiferal tests (*Orbitolites*, *Amphistegina*, *Sigmoïlina*, *Globigerina*, and *Truncatulina*), echinoid spines, brachiopods and lamellibranch shell-fragments. Glauconite is seen invading the interstices of the organic structures. |
| 212–215 .. | White to grey polyzoal rock; like certain fragments in sample 208–210 | ? *Lithophyllum* sp.<br>*Cellepora* sp. (a massive form). |
| 215–244 .. | A shelly and sandy deposit with phosphatic and glauconitic fragments | The following fossils occur here, denoting a Janjukian[1] facies.<br>Foraminifera.—*Miliolina seminulum*, L. sp.; *M. cuvieriana*, d'Orb. sp.; (?) *Trillina* sp.; *Orbitolites complanata*, Lam.; *Haplophragmium sphaeroidiniforme*, Brady; *Spiroplecta sagittula*, Defr. sp.; *Bolivina nobilis*, Hantken; *Lagena squamosa*, Mont. sp.; *Polymorphina elegantissima*, P. and J.; *Globigerina triloba*, Rss.; *Truncatulina haidingeri*, d'Orb. sp.; *T. ungeriana*, d'Orb. sp.; *Rotalia soldanii*, d'Orb.; *Polystomella crispa*, L. sp.; *P. verriculata*, Brady; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.; *O. complanata*, var. *granulosa*, Ley.; *O. venosa*, F. and M. sp.<br>Anthozoa.—*Sphenotrochus emarciatus*, Duncan; *Bathyactis lens*, Dunc. sp.; *Mopsea tenisoni*, Chapm.<br>Vermes.—*Ditrupa cornea*, L. sp. var. *constricta*, var. nov.<br>Polyzoa.—*Selenaria cupola*, T. W. sp.; *S. marginata*, T. W.; *Bipora philippinensis*, Busk sp.; *Cellepora fossa*, Hasw. sp.<br>Pelecypoda.—*Limopsis beaumariensis*, Chapm.; *Arca* (*Fossularca*) *dissimilis*, Tate sp.; *Pecten murrayanus*, Tate; *Cardita calva*, Tate; *C. latissima*, Tate; *Corbula coxi*, Pilsbry.<br>Scaphopoda.—*Dentalium aratum*, Tate.<br>Gasteropoda.—*Natica hamiltonensis*, Tate; *Turritella platyspira*, T. W.; *Pyramidella jonesiana*, Tate sp.<br>Crustacea.—*Cythere dictyon*, G. S. B.; chelæ of crabs, indet.<br>Pisces.—Fish otoliths (teleostean). |

### Notes on Bore No. 1.

From 154 to 210 feet the strata passed through are evidently of Kalimnan age.

The sample 208 to 210 feet seems to contain a mixture of Kalimnan and Janjukian species, as shown by the occurrence of *Glycimeris convexus* and *G. halli*, together with *Limopsis insolita* and the fragments of polyzoal rock.

Samples 210 to 244 clearly indicate a Janjukian facies.

[1] For explanation of this and other terms, see pp. 409, 411.

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### BORE No. 2.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 1–5 .. | A fine, dark-brown, loamy sand | Residue, after elutriation, a fine angular quartz sand, with a few larger, well-rounded particles; numerous vegetable fibres. |
| 5–29 .. | A pale soapy or steatitic clay | Residue gives a fine, sub-angular quartz sand. |
| 29–31 .. | A white quartz sand .. | Grains sub-angular. No wind-worn particles noticed. Some minute grains of ferruginous-stained sand present. |
| 31–37 .. | Quartz sand .. .. | Sub-angular and rounded grains, slightly more iron-stained than the preceding. |
| 37–46 .. | Fine and coarse white quartz sand | Finer portion angular; coarse, sub-angular to rounded. |
| 46–99 .. | Quartz sand coarser than the preceding | Sub-angular to rounded grains. Chalcedony of a bluish colour present. |
| 99–104 .. | Quartz sand with mica flakes | Finer sand grains coated with limonitic clay. |
| 104–109 .. | Quartz sand, rather fine | Sub-angular to rounded grains. |
| 109–110 .. | Pebbles of milky quartz and (?) lydite | Pebbles measuring from 5 to 17 mm. in their longest diameter. |
| 110–113 .. | Gritty ironstone with occasional flakes of mica | Showing banding and concretionary structure. |
| 113–117 .. | A pinkish, incoherent sandstone, with a small amount of clay | Washings yield a fine angular quartz sand. |
| 117–123 .. | A fine, brown, sandy clay | Chiefly fine quartz sand. Residuum with fragments of echinoid spines, sponge spicules indet. and a few small foraminiferal tests. The latter comprise *Polymorphina lactea*, W. and J. sp.; *Pullenia quinqueloba*, Rss.; *Truncatulina refulgens*, Montf. sp.; and *Polystomella crispa*, L. sp. |
| 123–157 .. | Pink sand (incoherent), with some clay and mica flakes | Residue, a fine angular sand. |
| 157–198 .. | A dark-green glauconitic clay with foraminifera | Numerous tests of *Polystomella crispa*, L. sp. Also some good internal casts of the same shells in glauconite. Some fragments of echinoid spines present. |
| 198–200 .. | A glauconitic sandy deposit with shells; forming a veritable shell-bank | Fossil contents—<br>This fauna proves the horizon to be at the summit of the Janjukian and the base of the Kalimnan.<br>Foraminifera.—*Biloculina irregularis*, d'Orb.; *Miliolina vulgaris*, d'Orb. sp. (several); *Polymorphina regina*, B. P. and J.; *Truncatulina ungeriana*, d'Orb. sp.; *Rotalia clathrata*, Brady; *R. beccarii*, L. sp.; *R. papillosa*, var. *compressiuscula*, Brady; *Polystomella crispa*, L. sp. (common).<br>Anthozoa.—*Bathyactis beaumariensis*, Dennant.<br>Pelecypoda.—*Leda apiculata*, Tate; *Limopsis beaumariensis*, Chapm.; *Lissarca rubricata*, Tate sp.; *Glycimeris convexus*, Tate sp.; *G. halli*, Pritchard; *Margaritifera crassicardia*, Tate sp.; *Trigonia margaritacea*, var. *acuticostata*, McCoy; *Crassatellites kingicoloides*, Pritch.<br>*Venus (Chione) propinqua*, T. W. sp.<br>Scaphopoda.—*Dentalium mantelli*, Zittel. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 2—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 198–200—*continued.* | .. .. .. | Fossil contents—*continued.*<br>Gasteropoda.—*Natica cunninghamensis*, Harris; *N. subinfundibulum*, Tate; *N. hamiltonensis*, Tate; *Turritella tristira*, Tate; *Tylospira coronata*, Tate sp.; *Cassis contusa*, Tate (fragment); *Lotorium tortirostre*, Tate sp.; *Tudicla turbinata*, Tate; *Ancilla hebera*, Hutton sp.<br>Ostracoda.—*Macrocypris tumida*, G. S. B.; *Bythocypris tumefacta*, Chapm.; *Cytherella pulchra*, G. S. B. |
| 200–206 .. | Fragments of glauconitic limestone with shells | The following fossils were determined:—*Miliolina vulgaris*, d'Orb. sp.; *Trillina howchini*, Schl.; *Orbitolites complanata*, Lam.; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.; *Venus* (*Chione*) sp.; *Niso psila*, T. W. (with interior filled with glauconite); *Turritella tristira*, Tate.<br>In thin sections of the rock the undermentioned fossils were noticed:—*Textularia* sp.; *Bolivina* sp.; *Globigerina* sp.; *Truncatulina* sp.; *Amphistegina* sp.; *Ditrupa* sp.; echinoid spines, and polyzoa. |
| 206–211 .. | A white, cavernous, fossiliferous limestone, resembling the typical polyzoal rock of Mount Gambier | Containing the following:—*Orbitolites complanata*, Lam. (large specimens); *Ditrupa* sp.; casts of indeterminate polyzoa; *Pecten murrayanus*, Tate; *Turritella murrayana*, Tate; *Cerithium apheles*, T. Woods. |
| 211–240 .. | A fine glauconitic and calcareous sand, with abundant foraminifera | The organisms in this sample are chiefly foraminiferal tests; but echinoid spines, a polyzoan, and ostracod valves are also present.<br>Foraminifera.—*Miliolina vulgaris*, d'Orb. sp. (frequent); *M. cuvieriana*, d'Orb. sp.; *M. seminulum*, L. sp.; *Trillina howchini*, Schlumberger (very common); *Orbitolites complanata*, Lam. (numerous fragments of large tests); *Haplophragmium sphaeroidiniforme*, Brady; *Gaudryina rugosa*, d'Orb.; *Polymorphina elegantissima*, P. and J.; *P. oblonga*, d'Orb.; *Truncatulina ungeriana*, d'Orb. sp. (common); *Rotalia papillosa*, var. *compressiuscula*, Brady; *R. beccarii*, L. sp.; *Polystomella macella*, F. and M. sp.; *P. crispa*, L. sp.; *Operculina complanata*, Defr.<br>Polyzoa.—*Cellaria australis*, MacGill.<br>Ostracoda.—*Cytheropteron batesfordiense*, Chapm. |

### Notes on Bore No. 2.

The Kalimnan series is clearly in evidence at 157 feet, and persists to 200 feet.

From 200 feet down to 240 feet the bore penetrated a glauconitic limestone followed by polyzoal rock and glauconitic sands, the latter resembling similar deposits in the Spring Creek series and the Aldinga beds.

## Details of Bores Nos. 1 to 11, etc.—*continued.*

BORE No. 3.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| | Samples of overlying rocks not sent in for examination. | |
| 201–220 .. | Blue clay with shells and glauconite. Only residue of shell-sand submitted for examination | The following fossils were identified :—<br>Algae. — *Lithothamnion ramosissimum*, Reuss. sp.<br>Foraminifera.—*Miliolina vulgaris*, d'Orb. sp. ; *Orbitolites complanata*, Lam. ; *Gaudryina rugosa*, d'Orb. ; *G. pupoides*, d'Orb. ; *Cassidulina subglobosa*, Brady ; *Nodosaria raphanus*, L. sp. ; *P. elegantissima*, P. and J. ; *P. oblonga*, d'Orb. ; *Truncatulina ungeriana*, d'Orb. sp. ; *T. haidingeri*, d'Orb. sp. ; *Rotalia orbicularis*, d'Orb. sp. ; *R. beccarii*, L. sp. ; *R. papillosa*, Brady ; *R. clathrata*, Brady ; *Polystomella crispa*, L. sp. ; *P. verriculata*, Brady ; *Amphistegina lessonii*, d'Orb. (common) ; *Operculina complanata*, Defr. (common) ; *O. complanata*, var. *granulosa*, Ley. (common).<br>Anthozoa.—*Sphenotrochus emarciatus*, Duncan ; *Deltocyathus fontinalis*, Dennant ; *Bathyactus beaumariensis*, Denn. ; *Mopsea tenisoni*, Chapm.<br>Echinodermata.—Spines of echinoids, several forms ; *Clypeaster gippslandicus*, McCoy (fragment) ; *Pentagonaster* sp.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy.<br>Polyzoa.—*Cellaria rigida*, MacGill. ; *Selenaria marginata*, T. W. ; *S. cupola*, T. W. sp. ; *Bipora cancellata*, Busk sp. ; *B. philippinensis*, Busk sp. ; *Cellepora fossa*, Hasw. sp. ; *C. tridenticulata*, var. *nummularia*, Busk ; *Retepora* sp.<br>Pelecypoda.—*Limopsis beaumariensis*, Chapm. (common) ; *Glycimeris halli*, var. *intermedia*, Pritch. ; *Cardita calva*, Tate ; *C. compacta*, Tate ; *C. latissima*, Tate ; *Corbula pyxidata*, Tate.<br>Scaphopoda.—*Dentalium mantelli*, Zittel.<br>Gasteropoda. — *Teinostoma pulcherrima*, Chapm. and Gabr. (var.) ; *Clanculus* sp. aff. *aloysii*, T. Woods ; *Liopyrga quadricingulata*, Tate ; *Natica substolida*, Tate ; *Turritella tristira*, Tate ; *Marginella wentworthi*, T. W. ; *M. praeformicula*, Chapm. and Gabr. ; *Ancilla hebera*, Hutton sp. ; *Pleurotoma selwyni*, Pritchard.<br>Ostracoda.—*Cythere postdeclivis*, Chapm.<br>Brachyura.—Chelæ of crabs, indet.<br>Pisces.—Teleostean otoliths (common) ; palatal remains, probably of *Diodon* and Rays ; teeth of (?) *Chrysophrys*. |
| 206 .. | Fragments of a hard glauconitic limestone, with remains of shell, polyzoa, &c. | Organisms identified :—A finely cellular, foliaceous, encrusting alga, referable to *Lithothamnion* sp. ; *Orbitolites complanata*, Lam, (tests large) ; *Placotrochus* sp. ; *Cellepora* (?) *gambierensis*, T. W. ; *Cellaria*, cf. *rigida*, MacGill. *Selenaria* sp. ; *Serpula ouyenensis*, Chapm. ; also various indeterminate bivalves and gasteropods. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### Bore No. 3—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| About 210 | Hard brown to green glauconitic and calcareous sandstone, with foraminifera and polyzoa | Fragmentary tests of *Orbitolites complanata*, Lam.; (?) *Placotrochus ; Serpula ouyenensis*, Chapm. ; fragmentary mollusca, indet. |
| About 212 | Hard glauconitic and calcareous sandstone | Some glauconite fragments of a bright-green colour.<br>Part of a large test of *Orbitolites complanata*, Lam., measuring 15.5 mm. in diameter. |
| 226 .. | A shelly and glauconitic sand | Algae.—*Lithothamnion ramosissimum*, Rss. sp.<br>Foraminifera.—*Miliolina vulgaris*, d'Orb. sp. ; *Orbitolites complanata*, Lam. (numerous large impressions) ; *Nodosaria* (*D.*) *obliqua*, L. sp. ; *Polymorphina elegantissima*, P. and J. ; *Discorbina globularis*, d'Orb. sp. ; *Truncatulina ungeriana*, d'Orb. sp. ; *T. haidingeri*, d'Orb. sp. ; *Gypsina howchini*, Chapm. ; *Rotalia clathrata*, Brady ; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr. ; *O. complanata*, var. *granulosa*, Ley.<br>Anthozoa.—*Placotrochus deltoideus*, Duncan ; *P. elongatus*, Dunc. ; *Sphenotrochus emarciatus*, Dunc. ; *Bathyactis* cf. *beaumariensis*, Denn. ; *Graphularia senescens*, Tate sp. ; *Mopsea tenisoni*, Chapm. ; *M. hamiltoni*, Thomson sp. ; *Isis compressa*, Dunc.<br>Crinoidea.—(?) *Antedon* sp.<br>Asteroidea.—*Pentagonaster* sp.<br>Echinoidea.—*Arachnoides* (*Monostychia*) *australis*, Laube sp. ; *Echinocyamus* (*Scutellina*) *patella*, Tate sp. ; echinoid spines, indet.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy, and var. *constricta*, Chapm.<br>Polyzoa.—*Cellaria rigida*, var. *perampla*, Waters ; *C. acutimarginata*, MacGill. sp. ; *Selenaria cupola*, T. W. sp. ; *S. marginata*, T. W. ; *Adeona* sp. (anchoring roots) ; *Bipora cancellata*, Busk sp. ; *B. philippinensis*, Busk sp. ; *Porina gracilis*, M. Edw. sp. ; *Cellepora fossa*, Hasw. sp. ; *C. tridenticulata*, var. *nummularia*, Busk ; *Schismopora incus*, MacGill. ; *Retepora* sp. ; *Idmonea* sp. ; *Lichenopora wilsoni*, MacGill. sp.<br>Pelecypoda. — *Limopsis beaumariensis* Chapm. ; *Glycimeris convexus*, Tate sp. ; *Margaritifera crassicardia*, Tate sp. ; *Trigonia margaritacea*, var. *acuticostata*, McCoy ; *Pecten murrayanus*, Tate ; *Dimya dissimilis*, Tate ; *Arcoperna scapha*, Verco ; *Crassatellites kingicoloides*, Pritchard ; *Cardita calva*, Tate ; *C. spinulosa*, Tate ; *Cuna radiata*, Tate sp. ; *Venus* (*Chione*) *hormophora*, Tate sp. ; *Corbula ephamilla*, Tate ; *C. coxi*, Pilsbry.<br>Scaphopoda.—*Dentalium aratum*, Tate ; *Dentalium australe*, Sharp and Pilsbry. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 3—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 226—*continued.* | .. .. .. | Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Eglisia triplicata*, Tate sp.; *Natica substolida*, Tate; *Turritella tristira*, Tate; *T. circumligata*, Verco.; *T. platyspira*, T. W.; *Tylospira coronata*, Tate sp.; *Lotorium* cf. *tumulosum*, Tate sp.; *Zemira praecursoria*, Tate; *Tudicla costata*, Tate; *Fasciolaria rugata*, Tate; *Marginella præformicula*, Chapm. and Gabr.; *Voluta weldi*, T. W.; *Ancilla hebera*, Hutton sp.; *Terebra simplex*, T. Woods; *T. geniculata*, Tate; *Pleurotoma trilirata*, Harr.; *Pleurotoma* (*Drillia*) *trevori*, T. W. sp.; *Bela sculptilis*, Tate.<br>Crustacea.—Chelæ of crab, indet.<br>Pisces.—*Lamna compressa*, Ag.; Chimæroid teeth (fragments); (?) *Chrysophrys* (tooth); teleostean fish otoliths, indet. |
| About 260 | Fragments of fine-grained fossiliferous, calcareous sandstone; sometimes glauconitic | Algae.—*Lithothamnium* (a foliaceous and encrusting form).<br>Foraminifera.—*Miliolina vulgaris*, d'Orb. sp.; *Trillina howchini*, Schlumb.; *Orbitolites complanata*, Lam.; *Polymorphina gibba*, d'Orb.; *Patellina corrugata*, Will. sp.; *Truncatulina ungeriana*, d'Orb. sp.; *Anomalina polymorpha*, Costa; *Polystomella imperatrix*, Brady; *Operculina complanata*, Defr.<br>Anthozoa.—*Placotrochus elongatus*, Duncan.<br>Echinodermata.—*Arachnoides* (*Monostychia*) *australis*, Laube sp.<br>Polyzoa.—*Cellepora* sp. (a massive form); (?) *Schizoporella* sp.<br>Gasteropoda.—*Turritella murrayana*, Tate (a cast)<br>Ostracoda.—*Cytherella pulchra*, G. S. B. |

### Notes on Bore No. 3.

This series is very imperfect, the samples commencing at 201 feet. There is an admixture of Kalimnan and Janjukian forms in the blue clay from 201 to 220 feet, typical fossils of the Kalimnan from this sample being *Glycimeris convexus*, *Limopsis beaumariensis*, *Liopyrga quadricingulata*, and *Bathyactis beaumariensis*. Among the Janjukian fossils we may cite *Deltocyathus fontinalis*, *Pentagonaster* sp., and *Pleurotoma selwyni*.

The shelly and glauconitic sand from 226 feet is an almost clean deposit with a Janjukian fauna, but a few Kalimnan types, as *Limopsis beaumariensis* and *Cardita calva*, are still in evidence.

The glauconitic and calcareous sandstone at 260 feet is essentially Janjukian; whilst the presence of *Trillina howchini* points to a lower phase of the Janjukian series.

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### BORE No. 4.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 163–170 .. | Soft blue clay with shells | Algae.—*Lithothamnion ramosissimum*, Rss. sp.<br>Foraminifera.—*Trillina howchini*, Schlumb.; *Orbitolites complanata*, Lam.; *Textularia gibbosa*, d'Orb.; *Bolivina punctata*, d'Orb.; *Frondicularia lorifera*, Chapm.; *Cristellaria rotulata*, Lam. sp.; *Polymorphina compressa*, d'Orb.; *Truncatulina haidingeri*, d'Orb. sp.; *T. ungeriana*, d'Orb. sp.; *Anomalina ammonoides*, Rss. sp.; *Gypsina globulus*, Rss. sp.; *Nonionina scapha*, F. and M. sp.; *Polystomella crispa*, L. sp.; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr. sp.; *O. complanata*, var. *granulosa*, Ley.<br>Anthozoa. — *Bathyactis beaumariensis*, Denn.; *B. lens*, Duncan, sp. (var. with basal epitheca well developed); *Mopsea tenisoni*, Chapm.; *M. hamiltoni*, Thomson sp.<br>Echinodermata.—(?) *Antedon* sp. (ossicles); *Pentagonaster* sp. (ossicle); echinoids, indet. (spines and portions of tests).<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy and var. *constricta*, Chapm.<br>Polyzoa.—*Hornera diffusa*, MacGill.; *Entalophora* sp., near *sparsa*, Mapl.; *Selenaria cupola*, T. W. sp.; *Bipora philippinensis*, Busk sp.; *Retepora* sp.; *Cellepora fossa*, Hasw. sp.<br>Pelecypoda.—*Limopsis beaumariensis*, Chapm.; *Glycimeris cainozoicus*, T. W. sp.; *G. halli*, Pritch.; *Gryphæa tarda*, Hutton; *Pecten murrayanus*, Tate; *P. sturtianus*, Tate; *Amussium zitelli*, Hutton; *Crassatellites kingicoloides*, Pritch.; *Cardita solida*, Tate; *Cuna radiata*, Tate sp.; *Corbula ephamilla*, Tate; *C. coxi*, Pilsbry.<br>Scaphopoda.—*Dentalium mantelli*, Zittel.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Turritella pagodula*, Tate; *Ancilla hebera*, Hutton sp.; *Terebra subspectabilis*, Tate.<br>Crustacea.—*Bythocypris tumefacta*, Chapm.; *Cytherella pulchra*, G. S. B.; *Balanus psittacus* Molina sp.; *Scalpellum subquadratum*, Chapm.<br>Pisces.—Teleostean fish otoliths; *Galeocerdo aduncus*, Ag. (tooth); *Myliobatis moorabbinensis*, Chapm. and Pritch. |
| 180–190 .. | White granular limestone with few fossils | Foraminifera.—*Truncatulina haidingeri*, d'Orb. sp.; *Polystomella verriculata*, Br.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy, and var. *constricta*, Chapm.<br>Ostracoda.—*Bythocypris tumefacta*, Chapm.; *B. amygdaloides*, G. S. B. |

### Notes on Bore No. 4.

No samples above 163 feet were submitted for examination. The shelly deposit at that depth was much comminuted, probably to some extent due to using the percussion drill.

Sample 163 to 170 feet shows an admixture of Kalimnan and Janjukian fossils. About 6 lb. of material were sorted for the above determinations. The sample from 180 to 190 feet is a polyzoal limestone with a Janjukian facies.

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### BORE No. 5.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| Surface–3 | Brown ferruginous loamy sand | The washed residue consists mainly of quartz grains, the finer being angular, the coarser subangular. |
| 3–11 .. | Stiff, ferruginous, sandy clay of a reddish-brown colour | Sand, angular to subangular; chiefly clean quartz with a few jaspery and milky quartz particles. |
| 11–22 .. | Ferruginous sandstone (incoherent); with concretionary nodules | Sub-angular quartz particles. |
| 22–31 .. | Red ferruginous sand .. | Angular and sub-angular quartz grains. |
| 31–39 .. | Fine, light-red sand, with some coarse grit | Fine sand, angular; coarse sand, with sub-angular to rounded grains. |
| 39–51 .. | Coarse white sand .. | Grains sub-angular to rounded; chiefly milky quartz. |
| 51–62 .. | Very coarse white sand, with a small proportion of fine sand | Fine sand of clear angular quartz; coarse sand, chiefly milky quartz, with some chalcedony, grains sub-angular to rounded. |
| 62–120 .. | Very fine white sand, micaceous | Quartz grains angular; numerous flakes of white mica. |
| 120–124 .. | Fine and coarse white sand, micaceous | Chiefly milky quartz particles and occasional flakes of white mica. |
| 124–130 .. | Very fine white micaceous sand | Grains extremely angular. A fair proportion of flakes of white mica. |
| 130–133 .. | Fine ferruginous sand, with mica | Quartz sand sub-angular; white mica flakes frequent. |
| 133–138 .. | Hard shelly limestone .. | Polyzoa and bivalves, indet. |
| 138–155 .. | Yellow and ochreous sandy clay | Numerous foraminifera belonging to the following species:—*Truncatulina ungeriana*, d'Orb. sp.; *Rotalia beccarii*, L. sp.; *Polystomella crispa*, L. sp. |
| 155–159 .. | Green clay with shells .. | The colouration of the clay is due to the presence of glauconitic casts, chiefly of foraminifera.<br>The fossils found here are:—<br>Foraminifera.—*Polymorphina elegantissima*, P. and J.; *P. problema*, d'Orb.; *Rotalia beccarii*, L. sp.; *Polystomella crispa*, L. sp.<br>Anthozoa.—*Bathyactis beaumariensis*, Denn.<br>Echinodermata.—Fragments of tests and spines, indet.<br>Polyzoa.—*Selenaria marginata*, T. W., and var. *spiralis*, Chapm.<br>Pelecypoda.—*Glycimeris halli*, var. *intermedia*, Pritchard; *Crassatellites kingicoloides*, Pritch.; *Corbula coxi*, Pilsbry; *C. ephamilla*, Tate.<br>Scaphopoda.—*Dentalium australe*, Sharp and Pilsbry.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Calyptræa kalimnæ*, Chapm. and Gabr.; *Eglisia triplicata*, Tate sp.; *Turritella pagodula*, Tate; *Marginella wentworthi*, T. W.; *M. praeformicula*, sp. nov.<br>Pisces.—Fish otoliths (teleostean). |
| 159–162 .. | Fragments of hard, glauconitic rocks and shells | Pieces of molluscan shells invaded and partially replaced by glauconite. The shells are probably referable to *Crassatellites*. Fragments of rock bored by a perforating mollusc, the crypts measuring about 4 mm. in diameter. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 5—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 162–163 .. | Shells glauconitic fragments and sand | Echinodermata.—Cf. *Arachnoides* (*Monostychia* sp.<br>Pelecypoda.—*Glycimeris halli*, Pritch., and var. *intermedia*, Pritch.; *G. maccoyi*, Johnst. sp.; *Pecten murrayanus*, Tate (worn specimens); *Corbula ephamilla*, Tate.<br>Scaphopoda.—*Dentalium mantelli*, Zittel.<br>Gasteropoda.—*Cerithium torrii*, Tate. |
| 163–175 .. | Shell sand .. .. | Algae.—*Lithothamnion ramosissimum*, Rss. sp.<br>Foraminifera.—*Miliolina vulgaris*, d'Orb. sp.; *Orbitolites complanata*, Lam.; *Nodosaria affinis*, d'Orb.; *Planorbulina larvata*, P. and J.; *T. haidingeri*, d'Orb. sp.; *Pulvinulina calabra*, Costa sp.; *Rotalia beccarii*, L. sp.) *R. clathrata*, Brady; *Rotalia soldanii*, d'Orb.; *Gypsina howchini*, Chapman; *Polystomella crispa*, L. sp.; *P. verriculata*, Brady; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr., and var. *granulosa*, Ley.<br>Anthozoa. — *Bathyactis beaumariensis*, Denn.; *Graphularia senescens*, Tate sp.<br>Echinodermata.—*Pentagonaster* sp.; *Fibularia gregata*, Tate; fragments of echinoid tests and spines, indet.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy, and var. *constricta*, Chapm.<br>Polyzoa.—*Claviporella* sp.; *Caberea grandis* Hincks; *Selenaria marginata*, T. W.; *Bipora philippinensis*, Busk sp.; *Cellepora fossa*, Hasw. sp.; *Idmonea hochstetteriana*, Stol. sp.; *Hornera* sp.; *Retepora* sp.; *Lichenopora porosa*, MacGill.<br>Brachiopoda.—*Terebratulina catinuliformis*, Tate.<br>Pelecypoda.—*Limopsis beaumariensis*, Chapm.; *Glycimeris halli*, Pritch.; *Cardita calva*, Tate; *C. pecten*, Tate; *Corbula coxi*, Pilsbry; *Venus* (*Chione*) *propinqua*, T. W. sp.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Natica substolida*, Tate; *Turritella pagodula*, Tate; *T. tristira*, Tate; *Eglisia triplicata*, Tate sp.; *Marginella wentworthi*, T. W.<br>Crustacea.—*Cytherella polita*, G. S. B.; *C. lata*, G. S. B.; chelae of crabs, indet.<br>Pisces.—Teleostean fish otoliths (abundant); *Trygon*, cf. *rugosus*, Probst. sp. |
| 175–189 .. | Blue clay with shells .. | Algae.—*Lithothamnion ramosissimum*, Rss. sp. (branchlets).<br>Foraminifera.—*Orbitolites complanata*, Lam.; *Operculina complanata*, Defr.<br>Anthozoa.—*Bathyactis beaumariensis*, Denn.; *Deltocyathus* cf. *fontinalis*, Denn.<br>Echinodermata. — *Pentagonaster* sp.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.; *Fibularia gregata*, Tate; *Clypeaster gippslandicus*, McCoy; *Arachnoides* (*Monostychia*) *australis*, Laube sp.; (?) *Linthia* sp.; ***Lovenia forbesi***, T.W. sp. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 5—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 175–189—*continued.* | .. .. .. | Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy.<br>Polyzoa.—*Selenaria marginata*, T. W.; *Schizoporella* (?) *convexa*, MacGill.; *Lepralia gippslandii*, Waters; *Cellepora fossa*, Hasw. sp.; *C. tridenticulata*, var. *nummularia*, Busk; *Retepora* spp., indet.<br>Brachiopoda.—*Terebratulina catinuliformis*, Tate.<br>Pelecypoda.—*Glycimeris maccoyi*, Johnst. sp.; *G. halli*, and var. *intermedia*, Pritch.; *Gryphaea tarda*, Hutton; *Pecten eyrei*, Tate; *P. murrayanus*, Tate; *Dimya dissimilis*, Tate; *Venus (Chione) subroborata*, Tate sp.; *Corbula ephamilla*, Tate; *C. coxi*, Pilsbry; *Crassatellites*, cf. *kingicoloides*, Pritch.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *L. sayceana*, Tate; *Euchelus tasmanicus*, T. Woods; *Eglisia triplicata*, Tate sp.; *Natica cunninghamensis*, Harris; *Turritella pagodula*, Tate; *Fasciolaria rugata*, Tate; *Marginella præformicula*, sp. nov.; *Terebra subspectabilis*, Tate sp.; *Tylospira coronata*, Tate sp.<br>Crustacea.—Claws of crustacea, indet.<br>Pisces.—Otoliths of teleostean fishes; *Diodon formosus*, Chapm. and Pritch. (palatal tooth). |
| 189–190 .. | A friable, calcareous rock, with small fossils | Foraminifera.—*Orbitolites complanata*, Lam.; *Truncatulina ungeriana*, d'Orb. sp.; *T. haidingeri*, d'Orb. sp.; *Anomalina ammonoides*, Rss. sp.; *Rotalia clathrata*, Brady; *Polystomella crispa*, L. sp.<br>Echinodermata.—Echinoid spines, indet.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy.<br>Ostracoda.—*Argillœcia badia*, G. S. B.; *Bythocypris tumefacta*, Chapm.; *Cythere scintillulata*, G. S. B. |

### Notes on Bore No. 5.

Sub-aerial and fluviatile deposits of Recent and Pleistocene age obtain from the surface down to 133 feet. From 133 to 155 feet we have marine and estuarine conditions prevailing, as shown by the foraminifera, probably of Newer Pleistocene age. Then follows a Kalimnan deposit from 155 to 163 feet, as proved by the typical fossils *Glycimeris halli*, *Liopyrga quadricingulata*, *Turritella pagodula* and *Marginella muscarioides*. A mixed fauna prevails in samples 163 to 189, consisting of a few Kalimnan and many typical Janjukian fossils. From 189 to 190 feet the calcareous rock there found is typically Janjukian. One of the chief forms of interest found in the samples from 163 to 189 feet is *Turritella pagodula*, a gasteropod characteristic of the Kalimnan of Beaumaris, Port Phillip, and of Jemmy's Point, Gippsland Lakes.

## Details of Bores Nos. 1 to 11, etc.—*continued.*

BORE No. 6.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 4–14 .. | Reddish ochreous sand.. | Fine washings consist of ochreous clay. Quartz grains sub-angular to rounded. |
| 14–20 .. | Fine, pale, ochreous sand | Quartz grains in the washings angular to rounded. |
| 20–21 .. | Whitish fine-grained sandstone. | |
| 21–40 .. | Yellow sand .. .. | Sub-angular to rounded quartz grains. |
| 40–43 .. | White sand .. .. | Angular to rounded grains, chiefly quartz, with a few whitish felspathic particles. |
| 43–48 .. | Coarse reddish-yellow sand | Sub-angular to rounded quartz grains. |
| 48–56 .. | Fine yellow sand .. | Angular to sub-angular quartz grains. |
| 56–80 .. | Quartz grit .. .. | Sub-angular to rounded grains and pebbles. |
| 80–81 .. | Quartz grit cemented into hard rock by limonite | Angular to rounded grains (?) wind-polished. |
| 81–97 .. | Fine and coarse quartz sand | Sub-angular to rounded grains, probably wind-polished. Occasional mica flakes. |
| 97–100 .. | Fine and coarse yellow sand | Quartz grains sub-angular to rounded. Occasional mica flakes. |
| 100–104 .. | Arkose or granitic sand | Partially cemented by kaolin. |
| 104–114 .. | Consolidated dune-sand | Thin sections show this to be a quartzose dune-rock, with a large percentage of calcareous particles consisting of shell-fragments, echinoid spines and foraminifera, consolidated by calcareous cement. A few mica flakes present. In the disintegrated rock the following forms were seen :—*Truncatulina* cf. *ungeriana*, d'Orb. sp., and *Polystomella crispa*, L. sp. (several specimens). |
| 114–150 .. | Blue clay with shells .. | Foraminifera.—*Polymorphina elegantissima*, P. and J.; *P. compressa*, d'Orb.; *Uvigerina tenuistriata*, Rss.; *Truncatulina haidingeri*, d'Orb. sp.; *Rotalia beccarii*, L. sp.; *R. clathrata*, Brady; *Polystomella crispa*, L. sp.<br>Anthozoa.—*Bathyactis beaumariensis*, Dennant.<br>Echinodermata.—Fragments of tests and spines, indet.<br>Polyzoa.—*Cellaria australis*, MacGill.; *Lunulites* (?) *parvicella*, T. W. sp.; *Selenaria marginata*, T. W.; *Cellepora* cf. *tridenticulata*, Busk.<br>Brachiopoda.—*Terebratella portlandica*, Chapm.<br>Pelecypoda.—*Glycimeris halli*, and var. *intermedia*, Pritch.; *Limopsis beaumariensis*, Chapm. (juv.); *Erycina micans*, Tate sp.; *Cardita calva*, Tate; *C. pecten*, Tate; *C. compacta*, Tate; *Venus* (*Chione*) *propinqua*, T. W. sp. (juv.); *V.* (*Ch.*) *subroborata*, Tate sp.; *Dosinea grayi*, Zittel; *Corbula ephamilla*, Tate; *C. coxi*, Pilsbry.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Cyclostrema harriettæ*, Petterd; *Pyramidella jonesiana*, Tate sp.; *Natica perspectiva*, Tate; *N. cunninghamensis*, Harr.; *N. subvarians*, Tate; *Calyptraea corrugata*, Tate; *C. kalimnæ*, Chapm. and Gabr.; *Turritella pagodula*, Tate; *Eglisia triplicata*, Tate sp.; *Nassa spiraliscabra*, Chapm. and Gabr.; *Marginella præformicula*, Chapm. and Gabr.; *Pleurotoma* (*Drillia*) *dilectoides*, Chapm. and Gabr.<br>Ostracoda.—*Cythere lepralioides*, G. S. B.; *Cytherella punctata*, G. S. B.<br>Cirripedes.—*Balanus varians*, Sow.<br>Pisces.—Fish teeth, indet. Otoliths of teleosteans. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 6—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 150–154 .. | A shelly and glauconitic deposit | Some of the quartz grains in the sample are polished, evidently by the action of wind.<br>The fossils present are—<br>Foraminifera.—*Nodosaria* (*Dentalina*) *obliqua*, Linn. sp.; *Pulvinulina elegans*, d'Orb. sp.; *Rotalia clathrata*, Brady; *R. beccarii*, L. sp.; *Polystomella crispa*, L. sp.; *P. craticulata*, F. and M. sp.<br>Echinodermata.—*Clypeaster gippslandicus*, McCoy.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy.<br>Polyzoa.—*Selenaria marginata*, T. W., var. *lucens*, MacGill.<br>Pelecypoda.—*Crassatellites* sp.; *Cuna polita*, Tate sp.; *Corbula ephamilla*, Tate.<br>Gasteropoda.—*Ancilla* sp. (fragment); *Tylospira coronata*, Tate sp. A coprolite, indet. |
| 154–158 .. | Coarse shell sand .. | Foraminifera.—*Nodosaria* (*Dentalina*) *obliqua*, L. sp.; *Rotalia beccarii*, L. sp.; *R. clathrata*, Brady; *Polystomella crispa*, L. sp.; *P. craticulata*, F. and M. sp.<br>Echinodermata.—*Clypeaster gippslandicus*, McCoy.<br>Brachiopoda.—*Terebratella portlandica*, Chapm.<br>Pelecypoda.—*Glycimeris halli*, and var. *intermedia*, Pritch.; *G. convexus*, Tate sp.; *Limopsis insolita*, Sow. sp.; *L. beaumariensis*, Chapm.; *Trigonia margaritacea*, var. *acuticostata*, McCoy; *Venus* (*Chione*) *subroborata*, Tate sp.; *V.* (*Ch.*) *hormophora*, Tate sp.; *Crassatellites kingicoloides*, Pritch.; *Corbula ephamilla*, Tate.<br>Scaphopoda.—*Dentalium australe*, Sharp and Pilsbry.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Natica cunninghamensis*, Harris; *Tylospira coronata*, Tate sp.; *Cassis* (*Semicassis*) *subgranosa*, Tate sp.; *Ancilla hebera*, Hutton sp.; *A. papillata*, Tate sp.; *Terebra angulosa*, Tate. |
| 158–161 .. | Sand with shells .. | This material contains numerous small rounded pebbles.<br>Fossils :—<br>Foraminifera.—*Polymorphina elegantissima*, P. and J.; *Truncatulina haidingeri*, d'Orb.; *Rotalia beccarii*, L. sp.; *R. clathrata*, Brady; *Polystomella craticulata*, F. and M. sp.<br>Anthozoa.—*Placotrochus deltoideus*, Dunc.; *P. elongatus*, Dunc.; *Sphenotrochus emarciatus*, Dunc.; *Bathyactis beaumariensis*, Dunc.; *B. lens*, Dunc. sp.; *Notophyllia variolaris*, Denn.<br>Echinodermata.—Fragments of echinoid tests, indet.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy.<br>Polyzoa.—*Selenaria marginata*, T. W., and var. *lucens*, MacGill.; *S. cupola*, T. W. sp.; *Bipora philippinensis*, Busk sp.; *Cellepora tridenticulata*, Busk. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 6—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 158–161—*continued.* | .. .. .. | Fossils—*continued.*<br>Pelecypoda.—*Nucula semistriata*, Tate; *Glycimeris halli*, and var. *intermedia*, Pritch. *G. maccoyi*, Johnst. sp.; *Limopsis beaumariensis*, Chapm., and var. *depressa*, Ch.; *Trigonia margaritacea*, var. *acuticostata*, McCoy; *Pecten antiaustralis*, Tate; *Cardita calva*, Tate; *C. spinulosa*, Tate; *Corbula ephamilla*, Tate; *C. pyxidata*, Tate; *Venus* (*Chione*) *propinqua*, T. W. sp.; *V.* (*Ch.*) *subroborata*, Tate sp.; *V.* (*Ch.*) *hormophora*, Tate sp.; *Barnea tiara*, Tate (dorsal valve).<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Rissoa* (*Onoba*) *bassiana*, Hedley; *Calyptræa corrugata*, Tate; *C. kalimnæ*, Chapm. and Gabr.; *Natica cunninghamensis*, Harr.; *N. perspectiva*, Tate; *N.* (?) *substolida*, Tate; *Turritella tristira*, Tate; *Tylospira coronata*, Tate sp.; *Marginella præformicula*, Chapm. and Gabr.; *Ancilla papillata*, Tate; *Pleurotoma* (*Drillia*) *dilectoides*, Chapm. and Gabr.<br>Crustacea.—*Balanus varians*, Sow.; claw of crab, indet.<br>Pisces.—Otoliths of teleosteans. |

### Notes on Bore No. 6.

The first 104 feet are composed of subaerial accumulations. At 104 to 114 feet there is an extremely interesting occurrence of consolidated dune-sand material, with shallow-water foraminifera. From 114 to 154 feet the deposits represent the Kalimnan stage, in which *Turritella pagodula* (a species from the Jemmy's Point beds) again occurs, as in Bore No. 5. From 154 to 161 feet the fauna represented is an admixture of Kalimnan and Janjukian species.

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BORE No. 7.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| Surface–4 | Reddish sandy loam .. | Quartz grains, sub-angular to well-rounded. |
| 4–8 .. | Boulders of hard limestone | Residue, after dissolving in acid, a little quartz sand. In thin sections this limestone shows spheroidal aggregates surrounded by a white calcareous border, and scattered through the matrix are numerous vestiges of (?) organic reticulate structure. Alternations of moist and dry conditions would account for the formation of the nodules. (See Tate, Trans. Roy. Soc. S. Aust., vol. XXII., p. 236.) |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### Bore No. 7—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 8–14 .. | Red and white clay (steatitic), with some sand | Quartz grains sub-angular. |
| 14–20 .. | Pink and white steatitic clay | No sand. |
| 20–33 .. | Pale-pink and green steatitic clay, with a fair proportion of sand grains | Sub-angular quartz grains. |
| 33–42 .. | Yellow sand (limonitic) | Sub-angular quartz grains. |
| 42–47 .. | White sand .. .. | Sub-angular quartz grains. |
| 47–71 .. | Fine white sand .. | Sub-angular quartz grains. |
| 71–78 .. | Yellow limonitic sand, with some clay | Sub-angular quartz grains. |
| 78–80 .. | Coarse white sand .. | Water found on touching this stratum. Quartz grains tolerably well rounded. |
| 80–85 .. | Yellow sandy clay .. | Washings consist of sub-angular quartz grains and particles of limonite. |
| 85–105 .. | Coarse sand .. .. | Sub-angular quartz grains, averaging 2 mm. in diameter. |
| 105–130 .. | Fine white sand .. | Angular to sub-angular quartz grains. |
| 130–132 .. | Very fine micaceous sand | Quartz grains angular to sub-angular. Mica (muscovite) flakes numerous. Also present a fair proportion of carbonaceous (? woody) fragments. |
| 132–142 .. | Fine black silt .. | Quartz grains and vegetable remains. |
| 142–142′ 3″ | Olive-green micaceous sandstone, with clay concretions | Concretions surrounding organic bodies having cancellated or cellular structure. |
| 142′ 3″–155 | Gritty sand with shells.. | Foraminifera.—*Truncatulina ungeriana*, d'Orb sp.; *Rotalia beccarii*, L. sp.; *Polystomella crispa*, L. sp.<br>Echinodermata.—Fragments of a test, indet.<br>Pelecypoda.—*Limopsis beaumariensis*, and var. *depressa*, Chapm.; *Leda crassa*, Hinds; *Limatula jeffreysiana*, Tate; *Mytilus deperditus*, Tate; *Montacuta sericea*, Tate; *Erycina micans*, Tate sp.; *Corbula ephamilla*, Tate; *Cardita compacta*, Tate; *Donax kenyoniana*, Chapm. and Gabr.; *Barnea tiara*, Tate.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Calyptræa corrugata*, Tate; *Marginella muscarioides*, Tate; *M. præformicula*, Chapm. and Gabr.; *Volvulella inflatior*, Cossm.<br>Crustacea.—*Loxoconcha australis*, G. S. B. |

## Notes on Bore No. 7.

Down to 142 ft. 3 in. the deposits are chiefly subaerial accumulations, some of the upper 130 feet being derived from granitic rocks, as evidenced by the quartz and mica. Below 130 feet evidence of fluviatile action is present; whilst at 142 feet the concretionary structure in the rock would seem to indicate ancient surface conditions. From 142 ft. 3 in. to the limit of the present boring—155 feet—the deposit is clearly of Kalimnan age, as shown by so typical a series of fossils as *Volvulella tatei*, *Marginella muscarioides*, *Liopyrga quadricingulata* and *Montacuta sericea*.

## Details of Bores Nos. 1 to 11, etc.—*continued.*

BORE No. 8.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| Surface–3 | Brown sand .. .. | Quartz grains sub-angular. |
| 3–10 .. | Concretionary limestone resembling "race," but in angular fragments | Containing some quartz sand. |
| 10–22 .. | Yellowish soapy clay .. | Steatitic. |
| 22–70 .. | Whitish sand .. | Sub-angular quartz grains. Occasional felspathic particles and mica flakes. |
| 70–71 .. | Incoherent brown sandstone | Sub-angular to rounded grains. |
| 71–95 .. | Dark-grey sand .. | Sub-angular quartz grains. |
| 95–102 .. | Coarse grey sand .. | Sub-angular to rounded quartz, with traces of marcasite adherent to the grains. A large proportion of milky or vein quartz. |
| 102–107 .. | Coarse grit .. .. | Cemented by marcasite. |
| 107–110 .. | Coarse and fine sand .. | Sub-angular to rounded quartz. |
| 110–124 .. | Coarse and fine grey sand | Angular and sub-angular grains. |
| 124–160 .. | Very fine grey sand .. | Contains a fair amount of mica. |
| 160–165 .. | Shell bed with a few quartz pebbles | At 160 feet a fish vertebra (non-selachian) was found.<br>The fossils occurring in this bed are:—*Spirorbis heliciformis*, Eichwald; *Nucula obliqua*, Lam.; *Barnea tiara*, Tate; *Donax kenyoniana*, Chapm. and Gabr. |
| 165–180 .. | Fine sand and shells .. | Foraminifera.—*Miliolina vulgaris*, d'Orb. sp.; *M. circularis*, Born. sp.; *M. seminulum*, L. sp.; *M. agglutinans*, d'Orb. sp.; *Polymorphina elegantissima*, P. and J.; *P. oblonga*, d'Orb.; *Rotalia clathrata*, Brady.<br>Anthozoa.—*Bathyactis beaumariensis*, Denn.<br>Echinodermata.—*Echinocyamus* (*Scutellina*) *patella*, Tate (with inframarginal periproct).<br>Polyzoa.—*Selenaria marginata*, T. W.; *S. marginata*, var. *spiralis*, Chapm.<br>Brachiopoda.—*Terebratulina catinuliformis*, Tate.<br>Pelecypoda.—*Nucula obliqua*, Lam.; *Leda huttoni*, T. W.; *L. woodsi*, Tate; *Glycimeris halli*, and vars. *intermedia* and *paucicostata*, Pritch.; *G. maccoyi*, Johnst. sp.; *Limopsis beaumariensis*, Chapm.; *Cardita compacta*, Tate; *C. calva*, Tate; *C. solida*, Tate; *Crassatellites communis*, Tate sp.; *Corbula coxi*, Pilsbry; *C. ephamilla*, Tate; *Venus* (*Chione*) *subroborata*, Tate sp.; *V.* (*Ch.*) *propinqua*, T. W. sp.; *Mactra hamiltonensis*, Tate; *Donax kenyoniana*, Chapm. and Gabr.; *Barnea tiara*, Tate.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *L. sayceana*, Tate; *Calyptræa corrugata*, Tate; *C. kalimnæ*, Chapm.; *Natica wintlei*, T. W.; *N. hamiltonensis*, Tate; *Rissoa* (*Onoba*) *bassiana*, Hedley; *R.* (*O.*) *chrysalida*, Chapm. and Gabr.; *Turritella pagodula*, Tate; *Marginella muscarioides*, Tate; *M. præformicula*, Chapm. and Gabr.<br>Crustacea.—*Balanus varians*, Sow. |
| 80–199 .. | Shell sand .. .. | Foraminifera.—*Miliolina seminulum*, L. sp.; *M. vulgaris*, d'Orb. sp.; *Polymorphina lactea*, W. and J. sp.; *P. compressa*, d'Orb.; *Rotalia beccarii*, L. sp.; *R. clathrata*, Br.; *Polystomella crispa*, L. sp. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 8—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 180–199—*continued.* | .. .. .. | Anthozoa.—*Bathyactis beaumariensis*, Denn.<br>Echinodermata.—Fragments of tests, indet.<br>Polyzoa.—*Lunulites canaliculata*, MacGill.; *Selenaria marginata*, T. W., and vars. *pulchella*, MacGill., and *spiralis*, Chapm.; *S. cupola*, T. W. sp.<br>Pelecypoda.—*Glycimeris halli*, Pritch.; *Limopsis beaumariensis*, Chapm.; *Cardita compacta*, Tate; *Corbula pyxidata*, Tate; *C. ephamilla*, Tate; *Venus (Chione) propinqua*, T. W. sp.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Liotia dennanti*, Chapm. and Gabr.; *Calyptræa corrugata*, Tate; *Natica hamiltonensis*, Tate; *Rissoa (Onoba) bassiana*, Hedley; *R. (O.) chrysalida*, Chap. and Gabr.; *R. varicifera*, T, W.; *Turritella pagodula*, Tate; *Eglisia triplicata*. Tate sp.; *Marginella præformicula*, Chap. and Gabr.; *Terebra geniculata*, Tate; *Pleurotoma (Drillia) dilectoides*, Chapm. and Gabr.<br>Crustacea.—*Balanus varians*, Sow.<br>Pisces.—Otoliths of teleosteans. |
| 199–204 .. | Deposit of large shells (for the most part broken) | Pelecypoda.—*Cucullæa corioensis*, McCoy; *Glycimeris halli*, and var. *intermedia*, Pritch.; *G. maccoyi*, Johnst. sp.; *Corbula ephamilla*, Tate; *C. coxi*, Pilsbry; *Venus (Chione) subroborata*, Tate sp.; *Crassatellites kingicoloides*, Pritch.<br>Gasteropoda.—*Nassa spiraliscabra*, Chapm. and Gabr.; *Natica perspectiva*, Tate; *N. substolida*, Tate; *Tylospira coronata*, Tate sp.; *Marginella muscarioides*, Tate; *M. præformicula*, Chapm. and Gabr. |
| 204–210 .. | Greenish sandy and shelly clay | Foraminifera.—*Miliolina seminulum*, L. sp.; *M. agglutinans*, d'Orb. sp.; *M. vulgaris*, d'Orb sp.; *Polymorphina lactea*, W. and J. sp.; *Rotalia clathrata*, Brady; *R. beccarii*, L. sp.; *Polystomella crispa*, L. sp.<br>Anthozoa.—*Bathyactis beaumariensis*, Denn.<br>Polyzoa.—*Cellaria australis*, MacGill.; *Selenaria marginata*, T. W., and var. *lucens*, MacGill.<br>Brachiopoda.—*Magasella compta*, Sow. sp.<br>Pelecypoda.—*Glycimeris halli*, and var. *intermedia*, Pritch.; *G. maccoyi*, Johnst. sp.; *Ostrea hyotidoidea*, Tate; *Limopsis beaumariensis* and var. *depressa*, Chapm.; *Cardita compacta*, Tate; *C. solida*, Tate; *Cuna concentrica*, Hedley; *Corbula coxi*, Pilsbry; *C. ephamilla*, Tate; *Crassatellites kingicoloides*, Pritch.; *Venus (Chione) propinqua*, T. W. sp; *Mactra hamiltonensis*, Tate.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Natica cunninghamensis*, Harr.; *Calyptræa kalimnæ*, Chapm. and Gabr.; *Rissoa (Onoba) bassiana*, Hedley; *R. (O.) chrysalida*, Chapm. and Gabr.; *Turritella pagodula*, Tate; *Marginella muscarioides*, Tate; *Pleurotoma selwyni*, Pritch.<br>Crustacea.—*Balanus varians*, Sow.<br>Pisces.—Otoliths of teleosteans. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 8—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 210–219 .. | A glauconitic and shelly sand, with numerous small bones and teeth (chiefly of fishes), and phosphatic particles | Foraminifera.—*Miliolina seminulum*, L. sp.; *M. vulgaris*, d'Orb. sp.; *M. oblonga*, Mont. sp.; *M. agglutinans*, d'Orb. sp.; *M. circularis*, Born. sp.; *Polymorphina oblonga*, d'Orb.; *P. problema*, d'Orb.; *P. compressa*, d'Orb.; *P. sororia*, Rss.; *P. elegantissima*, P. and J.; *P. regina*, B. P. and J.; *Anomalina ammonoides*, Rss. sp.; *Pulvinulina elegans*, d'Orb. sp.; *Rotalia clathrata*, Brady; *Polystomella crispa*, L. sp.; *P. craticulata*, F. and M. sp.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.; *Graphularia senescens*, Tate sp.<br>Polyzoa.—*Cellaria rigida*, MacGill.; *C. australis*, MacGill.; *Selenaria marginata*, T. W., and vars. *lucens*, MacGill., and *spiralis*, Chapm. and Gabr.<br>Pelecypoda.—*Limopsis beaumariensis*, Chapm.; *Ostrea manubriata*, Tate; *Cardita calva*, Tate; *C. compacta*, Tate; *Cuna polita*, Tate sp.; *Corbula ephamilla*, Tate; *C. coxi*, Pilsbry; *Venus (Chione) propinqua*, T. W. sp.<br>Polyplacophora.—(?) chitonids, indet. fragments.<br>Gasteropoda.—*Rissoa (Onoba) chrysalida*, Chapm. and Gabr.; *Terebra geniculata*, Tate.<br>Ostracoda.—*Macrocypris tumida*, G. S. B.; *Cythere lubbockiana*, G. S. B.; *C. rastromarginata*, G. S. B.; *C. lepralioides*, G. S. B.; *C. postdeclivis*, Chapm.; *Cytheropteron postumbonatum*, Chapm.; *Cytherella polita*, G. S. B.<br>Cirripedes.—*Balanus varians*, Sow.<br>Pisces.—*Cestracion cainozoicus*, Chapm. and Pritch.; *Carcharodon auriculatus*, Blainv. sp. (?) *Chrysophrys*; otoliths of teleosteans, indet. |
| 219–225 & 226–235 | Grey sandy rock .. | No determinable fossils. Some glauconitic casts. |
| 225–226 .. | Shell sand .. .. | Foraminifera.—*Miliolina seminulum*, L. sp.; *M. trigonula*, Lam. sp.; *Marginulina glabra*, d'Orb.; *Polymorphina compressa*, d'Orb.; *P.* cf. *oblonga*, d'Orb.; *Rotalia clathrata*, Brady.<br>Anthozoa.—*Bathyactis beaumariensis*, Denn.<br>Echinodermata.—Fragments of tests, indet.<br>Polyzoa.—*Cellaria australis*, MacGill; *Lunulites* sp.; *Selenaria marginata*, T. W., and var. *lucens*, MacGill.<br>Pelecypoda.—*Glycimeris halli*, Pritch.; *Limopsis beaumariensis*, Chapm.; *Crassatellites kingicoloides*, Pritch.; *Condylocardia tenuicostæ*, Chapm. and Gabr.; *Venus (Chione) propinqua*, T. W. sp.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Calyptræa corrugata*, Tate; *Turritella pagodula*, Tate; *T. platyspira*, T. W.; *Tylospira coronata*, Tate sp.; *Marginella muscarioides*, Tate. |

### Notes on Bore No. 8.

The same band of concretionary limestone occurs here, below 3 feet, as was shown in No. 7 Bore below 4 feet. It is here 7 feet thick, and is probably the calcareous representative of the ironstone bands occurring in the previous

bores at about the same depth. They both result, evidently, from the upward passage of meteoric water impregnated with iron or lime respectively. From 95–107 feet the strata is composed of a grit loosely consolidated by a deposit of marcasite.[1] Down to 124 feet the beds may be regarded as probably Pleistocene, but at 124–160 feet the character of the beds changes; the fine, grey, micaceous sand is equivalent to that in the previous bores with vegetable remains and estuarine foraminifera, and may represent the Upper Pliocene.

True Kalimnan (Lower Pliocene) strata occur at 160–165 feet. From 165 feet to near the base of this bore at 226 feet, the fossils indicate an admixture of Kalimnan and Janjukian strata, as indicated by the fossils *Bathyactis beaumariensis*, *Marginella muscarioides* and *Tylospira coronata* (Kalimnan), and *Graphularia senescens*, *Echinocyamus* (*Scutellina*) *patella*, and *Pleurotoma selwyni* (Janjukian). The glauconitic sand-rock of 226–235 feet probably indicates the presence of Lower Aldingan or Janjukian beds. From 210–235 feet the Janjukian facies is stronger than the Kalimnan.

On the whole, the samples from this bore show a greater admixture of fossils than from any other; an assortment accidental rather than natural.

BORE No. 9.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| Surface–3 | Brown sandy loam .. | Sub-angular to rounded quartz grains, iron-stained. |
| 3–14 .. | Pink sandy clay, with some carbonate of lime | Angular to rounded clear quartz grains. Pink concretionary granules of impure limestone. |
| 14–18 .. | Red ferruginous sand .. | Quartz sub-angular to rounded. |
| 18–45 .. | Stiff steatitic clay .. | A minute quantity of quartz sand present. |
| 45–56 .. | Yellow sand, with clay | Quartz sand, sub-angular to rounded. |
| 56–69 .. | Hard chalky limestone, with some quartz sand | In microscopic section seen to be concretionary, with angular particles of quartz, and spheroidal and spiral organic bodies which may have originally been land-shells. |
| 69–73 .. | Pinkish sand .. | Quartz fairly clear, with some jaspery particles. |
| 73–90 .. | Hard chalky and sandy rock | Similar to that from 56–69 feet. |
| 90–253 .. | Fine, grey, silty sand .. | Quartz somewhat angular; a few mica flakes and fragments of molluscan shells, indet. |
| 253–254 .. | Hard rock (no sample) | |
| 254–256 .. | Shell-sand with a little clay, forming an incoherent rock | Foraminifera.—*Miliolina seminulum*, L. sp.; *Rotalia beccarii*, L. sp.; *R. clathrata*, Brady; *Polystomella crispa*, L. sp.<br>Polyzoa.—*Cellaria australis*, MacGill.; *Selenaria cupola*, T. W. sp.; *S. marginata*, T. W., and vars. *lucens*, MacGill., and *spiralis*, Chapm.<br>Brachiopoda.—*Magasella compta*, Sow. sp.<br>Pelecypoda.—*Glycimeris halli* and var. *intermedia*, Pritch.; *G. maccoyi*, Johnst. sp.; *Nucula obliqua*, Lam.; *N. semistriata*, Tate; *Limopsis beaumariensis*, var. *depressa*, Chapm.; *Cardita calva*, Tate; *Cuna particula*, Hedley; *Corbula pyxidata*, Tate; *C. ephamilla*, Tate; *C. coxi*, Pilsbry; *Venus* (*Chione*) *propinqua*, T. W. sp.<br>Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Calyptræa corrugata*, Tate; *C. kalimnæ*, Chapm. and Gabr.; *Rissoa* (*Onoba*) *chrysalida*, Chapm. and Gabr.; *Turritella pagodula*, Tate.<br>Cirripedia.—*Balanus varians*, Sow.<br>Pisces.—(?) Fish remains, indet. |

[1] Determined by Mr. R. H. Walcott, F.G.S.

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 9—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 256–263 .. | A stiff glauconitic clay .. | Residuum after washing gives about 15 per cent. of ostracod valves.<br>Foraminifera.—*Biloculina elongata*, d'Orb.; *Miliolina seminulum*, L. sp.; *Nodosaria (Glandulina) lævigata*, d'Orb.; *N. (Dentalina) obliqua*, L. sp.; *Cristellaria cultrata*, Montf. sp.; *C. articulata*, Rss.; *Polymorphina oblonga*, d'Orb.; *Discorbina turbo*, d'Orb. sp.; *D. bertheloti*, d'Orb. sp.; *Anomalina polymorpha*, Costa; *Pulvinulina repanda*, F. and M. sp.; *Rotalia beccarii*, L. sp.; *R. clathrata*, Brady; *Polystomella crispa*, L. sp.<br>Anthozoa.—Cf. *Bathyactis beaumariensis*, (fragment), Denn.<br>Polyzoa.—*Selenaria cupola*, T. W. sp.<br>Pelecypoda.—*Pecten peroni*, Tate.<br>Gasteropoda.—*Calyptræa kalimnæ*, Chapm. and Gabr.<br>Ostracoda.—*Macrocypris decora*, G.S.B. sp.; *M. tumida*, G.S.B.; *Bairdia australis*, Chapm.; *Cythere canaliculata*, Rss. sp.; *Cythere militaris*, G. S. B.; *C. dictyon*, G. S. B.; *C. obtusalata*, G.S.B.; *Cytheropteron præantarcticum*, Chapm.; *Cytherella pulchra*, G. S. B.; *C. punctata*, G. S. B.<br>Crustacea.—Crustacean claws, indet.<br>Pisces.—Otoliths of teleostean fishes. |
| 263–273 .. | Consolidated shell-sand | Foraminifera.—*Miliolina seminulum*, L. sp.; *M. oblonga*, Montf. sp.; *M. agglutinans*, d'Orb. sp.; *Truncatulina ungeriana*, d'Orb. sp.; *Rotalia beccarii*, L. sp.; *Polystomella macella*, F. and M. sp.; *P. crispa*, L. sp.; *P. striatopunctata*, F. and M. sp., var. *evoluta*, Chapm.<br>Anthozoa.—*Bathyactis beaumariensis*, Denn.<br>Echinodermata.—Echinoid spines, indet.<br>Polyzoa.—*Cellaria australis*, MacGill.; *Selenaria cupola*, T. W. sp.; *S. marginata*, T. W., var. *lucens*, MacGill., and var. *spiralis*, Chapm.<br>Brachiopoda.—*Terebratella portlandica*, Chapm.<br>Pelecypoda.—*Nucula semistriata*, Tate; *Glycimeris halli* and var. *intermedia*, Pritch.; *Limopsis beaumariensis*, Chapm.; *Cucullæa corioensis*, McCoy; *Placunanomia ione*, Gray; cf. *Perna percrassa*, Tate sp. (fragment); *Corbula ephamilla*, Tate; *C. coxi*, Pilsbry; *Cardita calva*, Tate; *C. pecten*, Tate; *Cuna concentrica*, Hedley; *Venus (Chione) propinqua*, T. W. sp.; *V. (Chione) hormophora*, Tate, sp.; *Crassatellites kingicoloides*, Pritch; *Dosinea grayi*, Zittel.<br>Gasteropoda.—*Natica cunninghamensis*, Harr.; *Calyptræa corrugata*, Tate; *C. kalimnæ*, Chapm. and Gabr.<br>Cirripedia.—*Balanus varians*, Sow.<br>Pisces.—Otoliths of teleostean fishes. |
| 273–311 .. | Green sandy clay .. | Containing much glauconite. Also a garnet and a flake of biotite mica. Numerous small ovoid pellets occur in the washings, probably referable to fishes.<br>Foraminifera. — *Truncatulina ungeriana*, d'Orb. sp.; *Nonionina scapha*, F. and M. sp.<br>Echinodermata.—Fragments of tests and spines, indet. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### Bore No. 9—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 311–315 .. | Grey, gritty rock, with some calcareous particles | Organic fragments too much decayed for indentification. |
| 315–325 .. | Incoherent polyzoal rock, shells | Plantæ.—Parasitic borings of a fungus in shell of (?) *Dosinea.*<br><br>Foraminifera.—*Miliolina seminulum*, L. sp.; *M. bicornis*, W. and J. sp.; *Hauerina intermedia*, Howch.; *Orbitolites complanata*, Lam.; *Lagena gracilis*, Will.; *Nodosaria* (*Glandulina*) *lævigata*, d'Orb.; *Polymorphina oblonga*, d'Orb.; *Truncatulina haidingeri*, d'Orb. sp.; *Rotalia beccarii*, L. sp.; *R. clathrata*, Brady; *Polystomella crispa*, L. sp.; *P. craticulata*, F. and M. sp.; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr., var. *granulosa*, Ley.<br><br>Anthozoa.—*Sphenotrochus emarciatus*, Dunc.; *Deltocyathus fontinalis*, Denn.; *Bathyactis beaumariensis*, Denn.; *Notophyllia variolaris*, Denn.; *Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Fibularia gregata*, Tate; *Pentagonaster* sp.; echinoid plates and spines, indet.<br><br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy.<br><br>Polyzoa.—*Cellaria contigua*, MacGill.; *C. australis*, MacGill.; *Selenaria cupola*, T. W. sp.; *S. marginata*, T. W., and vars. *lucens*, MacGill., and *spiralis*, Chapm.; *Bipora philippinensis*, Busk sp.; *Lichenopora porosa*, MacGill.; *Idmonea lata*, MacGill.; *Heteropora pisiformis*, MacGill.<br><br>Brachiopoda.—*Terebratulina catinuliniformis*, Tate; *Magasella compta*, Sow. sp.; *M. lunata*, Tate.<br><br>Pelecypoda.—*Nucula semistriata*, Tate; *Glycimeris halli* and var. *intermedia*, Pritch.; *G. convexus*, Tate sp.; *Cucullæa corioensis*, McCoy; *Limopsis beaumariensis*, var. *depressa*, Chapm.; *Perna percrassa*, Tate sp.; *Ostrea hyotidoidea*, Tate; *O. manubriata*, Tate; *Gryphæa tarda*, Hutton; *Trigonia lamarcki*, Gray; *T. margaritacea*, var. *acuticostata*, McCoy; *T. howitti*, McCoy; *Pecten peroni*, Tate; *P. eyrei*, Tate; *Placunanomia ione*, Gray; *Crassatellites kingicoloides*, Pritch.; *Cardita solida*, Tate; *C. calva*, Tate; *C. pecten*, Tate; *Venus* (*Chione*) *propinqua*, T. W. sp. (juv.); *V.* (*Ch.*) *subroborata*, Tate sp.; *V.* (*Ch.*) *hormophora*, Tate sp.; *Dosinea grayi*, Zittel; *Mactra hamiltonensis*, Tate; *Corbula coxi*, Pilsbry; *C. ephamilla*, Tate.<br><br>Scaphopoda.—*Dentalium latesulcatum*, Tate; *D. australe*, Sharp and Pilsbry. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 9—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 315–325—*continued.* | .. .. .. | Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Rissoa* (*Onoba*) *bassiana*, Hedley; *Calyptræa corrugata*, Tate; *C. kalimnæ*, Chapm. and Gabr.; *Natica cunninghamensis*, Harr.; *N. hamiltonensis*, Tate; *N. subvarians*, Tate; *Turritella pagodula*, Tate; *T. tristira*, Tate; *Tylospira coronata*, Tate sp.; *Marginella præformicula*, Chapm. and Gabr.; *Voluta weldi*, T. W.; *Ancilla papillata*, Tate.<br>Crustacea.—*Balanus psittacus*, Molina sp.; *B. varians*, Sow.; *Macrocypris decora*, G. S. B.; *Cythere dictyon*, G. S. B.; *C. parallelogramina*, G. S. B.; *Cytherella polita*, G. S. B.: *C. pulchra*, G. S. B.<br>Pisces.—*Carcharodon auriculatus*, Blainv. sp. (tooth of a young individual); *Myliobatis moorabbinensis*, Chapm. and Pritch.; fish vertebra, indet.; otoliths of teleostean fishes. |

## Notes on Bore No. 9.

At several levels down to 90 feet, hard, calcareous and concretionary limestone bands occur. One bed in particular, at 56–69 feet, appears to be a deposit such as is found at the present day in and around the saline lagoons in central and parts of southern Australia, which are inhabited by mollusca such as *Coxiella* and other forms living in brackish water. These limestone deposits, found a little below the surface nearly all over the Mallee, are in all probability due, as explained by Howchin and Gregory[1], to the effect of the hot sun and dry wind causing the evaporation of the surface moisture (sometimes an inch per day), and a consequent upward suction of water charged with calcareous matter (sometimes ferruginous) from the lower depths. The deposition of this mineral matter takes place just beneath the surface of the loose soil, and results in a hard "pan."

Between this bore and the previous one some striking differences are noticed in the thickness of the superficial deposits. The usual bed of grey, micaceous, silty sand, for instance, is here represented by no less than 163 feet, as against that of 36 feet in bore No. 8. This points to a sudden deepening of the estuarine area at the present spot, caused by subsidence synchronous with deposition of silt. That the whole sedimentary series is thicker in the locality of bore No. 9 is indicated by the proportionally greater depth at which the Kalimnan beds lie under their Pleistocene cover; for we do not get typical Kalimnan fossils until 254 feet is reached, as compared with 160 feet of bore No. 8, thus showing a discrepancy of nearly 100 feet. The sample from 254–256 feet yields a typical Kalimnan facies; whilst at 256–263 feet the fauna contains an admixture of Janjukian species such as *Pecten peroni*. The large number of Ostracoda in the last-named sample is noticeable. The mixed faunal characters of Kalimnan and Janjukian obtain to the end of this boring at 315–325 feet.

[1] See Gregory, J. W., Geography of Victoria, 1903, p. 92. Also Howchin, W., Trans. Roy. Soc. S. Aust., Vol. XXVII., Pt. I., 1903, p. 84.

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### BORE No. 10.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| Surface–20 | Fine sand-rock of a light brown colour | Quartz grains angular to rounded. |
| 20–21 .. | Concretionary limestone in rounded nodules | |
| 21–30 .. | Light-coloured sand .. | Quartz grains angular to sub-angular. |
| 30–45 .. | Friable, concretionary limestone | A few sub-angular quartz grains present. |
| 45–58 .. | Whitish sand .. | Sub-angular quartz grains and a little argillaceous material present. |
| 58–72 .. | Green and brown sandy clay | Sub-angular quartz grains and argillaceous flakes. |
| 72–82 .. | A concretionary gypseous clay of a pale-green colour | Numerous gypsum crystals seen under a high power. |
| 82–85 .. | Stiff, grey, sandy clay .. | Quartz grains angular. |
| 85–87 .. | Concretionary argillaceous limestone | |
| 87–101 .. | Sticky black clay .. | Probably carbonaceous and pyritous. Turns red after heating. |
| 101–160 .. | Dark-grey quartz sand | Sub-angular quartz grains. |
| 160–186 .. | Pebbly and micaceous shell sand | A large proportion of white quartz pebbles and mica (both muscovite and biotite). Fossils present :— Foraminifera.—*Ammodiscus ovalis,* Chapm.; *Rotalia clathrata,* Brady ; *R. beccarii,* L. sp.; *Polystomella crispa,* L. sp. ; *P. striatopunctata,* F. and M. sp., var. *evoluta,* Chapm. Echinodermata.—Spines, indet. Pelecypoda.—*Leda woodsi,* Tate ; *Mactra axiniformis,* Tate ; *M. hamiltonensis,* Tate ; *M. howchiniana,* Tate ; *Corbula coxi,* Pilsbry. Gasteropoda.—*Liopyrga quadricingulata,* Tate ; *Natica substolida,* Tate ; *Pyramidella jonesiana,* Tate sp. Ostracoda.—*Macrocypris decora,* G. S. B. (juv.) ; *Cythere demissa,* G. S. B.; *Cytherella polita,* G. S. B. Pisces.—Otoliths of teleosteans. |
| 186–190 .. | Sandy and shelly clay, with quartz pebbles and mica flakes | Foraminifera.—*Miliolina oblonga,* Mont. sp. ; *M. trigonula,* Lam. sp.; *Rotalia beccarii,* L. sp.; *R. clathrata,* Brady ; *Polystomella crispa,* L. sp. Pelecypoda. — *Condylocardia tenuicostæ,* Chapm. and Gabr.; *Meretrix murrayana,* Tate sp.; *Mactra hamiltonensis,* Tate; *M. axiniformis,* Tate ; *M. howchiniana,* Tate ; *Donax kenyoniana,* Chapm. and Gabr.; *Corbula coxi,* Pilsbry. Gasteropoda.—*Volvulella inflatior,* Cossm. ; *Liopyrga quadricingulata,* Tate ; *Calyptræa corrugata,* Tate ; *C. kalimnæ,* Chapm. and Gabr.; *Natica substolida,* Tate ; *N. hamiltonensis,* Tate ; *Teinostoma depressula,* Chapm. and Gabr. ; *Pyramidella jonesiana,* Tate sp. ; *Marginella muscarioides,* Tate. |
| 190–195 .. | Hard concretions of a marly character | |
| 195–225 .. | Greenish sandy clay with shells | Foraminifera.—*Miliolina seminulum,* L. sp. ; *M. circularis,* Born. sp. ; *M. oblonga,* Mont. sp. ; *Frondicularia complanata,* Defr. ; *Polymorphina communis,* d'Orb. ; *Rotalia clathrata,* Brady ; *R. beccarii,* L. sp. ; *Polystomella striatopunctata,* F. and M. sp., var. *evoluta,* Chapm. ; *P. macella,* F. and M. sp. ; *P. crispa,* L. sp. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 10—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 195–225—*continued.* | .. .. .. | Spongiæ.—Calcareous spicules, indet.<br>Echinodermata.—Fragments of tests, indet.<br>Polyzoa.—*Catenicella* sp.<br>Pelecypoda.—*Meretrix murrayana*, Tate sp.; *Mactra hamiltonensis*, Tate; *M. axiniformis*, Tate; *Donax kenyoniana*, Chapm. and Gabr.<br>Gasteropoda.—*Tornatina aptycha*, Cossm.; *Cyclostrema homalon*, Verco; *Teinostoma depressula*, Chapm. and Gabr.; *Liopyrga quadricingulata*, Tate; *Pyramidella jonesiana*, Tate sp.; *Natica subinfundibulum*, Tate; *N. substolida*, Tate.<br>Ostracoda. — *Cythere parallelogramma*, G. S. B.; *C. lepralioides*, G. S. B.; *Loxoconcha australis*, G. S. B.; *Cytheropteron reticosum*, Chapm.; *Cytherella polita*, G. S. B. |
| 220 .. | .. .. .. | An enormous specimen of *Natica subinfundibulum*, var. *crassa*, Tate. The largest recorded specimen of Prof. Tate's has a length of 20 mm. Our example measures 50 mm. in length, and 52 mm. in width. |
| 225–230 .. | Green micaceous clay, with shells | Foraminifera.—*Miliolina seminulum*, L. sp.; *M. jerussacii*, d'Orb. sp.; *Polymorphina elegantissima*, P. and J.; *Rotalia beccarii*, L. sp.; *Polystomella crispa*, L. sp.<br>Echinodermata.—Fragments of tests and spines, indet.<br>Polyzoa.—*Cellaria australis*, MacGill.<br>Pelecypoda.—*Leda acinaciformis*, Tate; *Condylocardia tenuicostæ*, Chapm. and. Gabr.; *Erycina micans*, Tate sp.; *Cuna polita*, Tate sp.; *Venus (Chione) subroborata*, Tate sp.; *Mactra hamiltonensis*, Tate; *Donax kenyoniana*, Chapm. and Gabr.; *Barnea tiara*, Tate; *Corbula ephamilla*, Tate; *C. coxi*, Pilsbry.<br>Gasteropoda.—*Liopyrga sayceana*, Tate; *Teinostoma depressula*, Chapm. and Gabr.; *T. pulcherrima*, Chapm. and Gabr.; *Natica substolida*, Tate; *N. hamiltonensis*, Tate; *Eulima pinguicula*, Chapm. and Gabr.; *Turbonilla weecahensis*, Chapm. and Gabr.; *Rissoa gatliffeana*, Chapm. and Gabr.; *Pyramidella jonesiana*, Tate sp.; *Marginella hordeacea*, Tate; *M. muscarioides*, Tate; *Terebra profunda*, Chapm. and Gabr.<br>Crustacea.—*Cythere demissa*, G. S. B.; *Xestoleberis curta*, G. S. B.; *Loxoconcha australis*, G. S. B.; *Cytherella subtruncata*, Chapm. and Gabr.; claws of crab, indet.<br>Pisces.—*Myliobatis moorabbinensis*, Ch. and Pr.; otoliths of teleostean.<br>Note.—A very remarkable feature of this deposit is the nearly pure foraminiferal residue of the finer siftings, which consist almost entirely of the shells of the shallow water species *Rotalia beccarii*. So rich a residue with this species has not been before met with by the writer, the most nearly comparable being the Pleistocene estuarine clays of Magheramorne, near Belfast. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 10—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents |
|---|---|---|
| 230–254 .. | Green fossiliferous clay (glauconitic) | Shells comminuted as if by current action. Glauconite, replacing fragments of echinoderm tests, and borings of perforating algæ in shells; also occurring as casts in shells of the foraminifera.<br>Fossils—<br>Foraminifera.—*Polymorphina oblonga*, d'Orb.; *P. compressa*, d'Orb.; *P. elegantissima*, P. and J.; *Rotalia beccarii*, L. sp.<br>Echinodermata.—Echinoid spines, indet.<br>Polyzoa.—*Selenaria marginata*, T. Woods, vars. *lucens*, MacGill., and *spiralis*, Chapm.<br>Pelecypoda.—*Limopsis beaumariensis*, var. *depressa*, Chap.; *Nucula semistriata*, Tate; *Trigonia margaritacea*, var. *acuticostata*, McCoy; *Cardita calva*, Tate; *Cuna polita*, Tate sp.; *Venus (Chione) subroborata*, Tate sp.; *Dosinea* sp., indet.; *Corbula coxi*, Pilsbry.<br>Ostracoda.—*Cytherella pulchra*, G. S. Brady.<br>Pisces.—Fish remains, indet.; otoliths of teleosteans. |
| 254–296 .. | A greenish-coloured shell-marl | Foraminifera.—*Miliolina seminulum*, L. sp.; *M. vulgaris*, d'Orb. sp.; *Haplophragmium canariense*, d'Orb. sp.; *H. emaciatum*, Brady; *Nodosaria* sp. (fragment); *Polymorphina elegantissima*, P. and J.; *Discorbina parisiensis*, d'Orb. sp.; *Rotalia clathrata*, Brady; *R. beccarii*, L. sp.; *Nonionina scapha*, F. and M. sp.; *Polystomella crispa*, L. sp.<br>Anthozoa.—*Graphularia senescens*, Tate sp.<br>Echinodermata.—Echinoid spines, indet.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy.<br>Polyzoa.—*Selenaria marginata*, T. Woods, vars. *lucens*, MacGill., and *spiralis*, Chapm.<br>Brachiopoda.—*Magasella woodsiana*, Tate; *Terebratella portlandica*, Chapm.<br>Pelecypoda.—*Limopsis beaumariensis*, and var. *depressa*, Chapm.; *Glycimeris convexus*, Tate; *G. halli*, var. *intermedia*, Pritch.; *Trigonia margaritacea*, var. *acuticostata*, McCoy (fragment); *Crassatellites kingicoloides*, Pritch.; *Venus (Chione) hormophora*, Tate sp.; *Mactra hamiltonensis*, Tate; *Corbula ephamilla*, Tate; *C. coxi*, Pilsbry.<br>Scaphopoda.—*Dentalium australe*, Sharp and Pilsbry.<br>Gasteropoda.—*Calyptræa kalimnæ*, Chapm. and Gabr.; *Rissoa (Onoba) chrysalida*, Chapm. and Gabr.; *Zemira præcursoria*, Tate.<br>Cirripedes.—*Balanus varians*, Sow.<br>Pisces.—Otoliths of teleosteans, and other fish remains, indet. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 10—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 296–306 .. | Glauconitic clay .. | Foraminifera.—*Biloculina irregularis*, d'Orb.; *Lagena marginata*, W. and B.; *L. orbignyana*, Seg.; *Nodosaria badenensis*, d'Orb.; *Polymorphina elegantissima*, P. and J.; *P. compressa*, d'Orb.; *Truncatulina ungeriana*, d'Orb. sp.; *Rotalia clathrata*, Brady; *R. beccarii*, L. sp.; *Polystomella striatopunctata*, F. and M., var. *evoluta*, Chapm.; *P. crispa*, L. sp.<br>Echinodermata.—Echinoid spines, indet.<br>Gasteropoda.—*Terebra geniculata*, Tate.<br>Ostracoda.—*Cythere* sp., indet. (fragments only).<br>Pisces.—(?) fish pellets (excreta). |
| 306–310 .. | Calcareous rock, with glauconitic and phosphatic concretionary nodules | |
| 310–320 .. | A shelly and sandy marl, glauconite | Algae.—*Lithothamnion ramosissimum*, Rss. sp.<br>Foraminifera.—*Miliolina agglutinans*, d'Orb. sp.; *Sigmoïlina* sp. (cast in glauconite); *Planispirina exigua*, Brady; *Polymorphina regina*, B. P. and J.; *P. elegantissima*, P. and J.; *P. rotundata*, Born. sp.; *Truncatulina ungeriana*, d'Orb. sp; *T. haidingeri*, d'Orb. sp.; *Rotalia beccarii*, L. sp.; *R. clathrata*, Brady; *Polystomella macella*, F. and M. sp.; *P. crispa*, L. sp.; *P. verriculata*, Brady; *P. craticulata*, F. and M. sp.; *P. subnodosa*, Münst. sp.; *Operculina complanata*, Defr.; *O. complanata*, var. *granulosa*, Ley.<br>Anthozoa.—*Deltocyathus* sp. (fragment); *Bathyactis beaumariensis*, Denn.; *Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Fibularia gregata*, Tate; echinoid spines, indet.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy, and var. *constricta*, Chapm.<br>Polyzoa.—*Caberea grandis*, Hincks; *Cellaria australis*, MacGill.; *C. rigida*, MacGill.; *Selenaria cupola*, T. Woods sp.; *S. marginata*, T. Woods; *S. marginata*, var. *lucens*, MacGill.; *S.* cf. *concinna*, T. Woods (worn spec.); *Lepralia elongata*, MacGill.; *Bipora philippinensis*, Busk sp.; *Cellepora fossa*, Hasw. sp.; *Schismopora incus*, MacGill.; *Hornera frondiculata*, Lamx.; *Lichenopora australis*, MacGill.<br>Brachiopoda.—*Magellania* sp., indet.; *Terebratulina flindersi*, Chapm.; *Terebratella portlandica*, Chapm.<br>Pelecypoda.—*Limopsis beaumariensis*, var. *depressa*, Chapm.; *Glycimeris convexus*, Tate sp.; *Gryphæa tarda*, Hutton; *Pecten sturtianus*, Tate; *Dimya dissimilis*, Tate; *Crassatellites kingicoloides*, Pritch.; *Cardita spinulosa*, Tate; *Condylocardia tenuicostæ*, Chapm. and Gabr.; *Erycina micans*, Tate sp.; *Venus* (*Chione*) *subroborata*, Tate sp.; *V.* (*Ch.*) *hormophora*, Tate sp.; *Mactra hamiltonensis*, Tate; *Donax kenyoniana*, Chapm. and Gabr.; *Corbula ephamilla*, Tate; *C. coxi*, Pilsbry.<br>Scaphopoda.—*Dentalium mantelli*, Zittel |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 10—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 310–320—*continued.* | .. .. .. | Gasteropoda.—*Liopyrga quadricingulata*, Tate; *Calyptræa corrugata*, Tate; *Eglisia triplicata*, Tate sp.; *Turbonilla weeahensis*, Chapm. and Gabr.; *Marginella muscarioides*, Tate; *Terebra geniculata*, Tate; *Vaginella* cf. *eligmostoma*, Tate (cast).<br>Cirripedia.—*Balanus varians*, Sow.; *Scalpellum subquadratum*, Chapm.<br>Ostracoda.—*Macrocypris tumida*, G. S. B.; *Bythocypris tumefacta*, Chapm.; *Bairdia amygdaloides*, G. S. Brady; *Cythere normani*, G. S. B.; *C. wyville-thomsoni*, G. S. B.; *C. dictyon*, G. S. B.; *C. lactea*, G. S. B.; *C. postdeclivis*, Chapm.; *C. flexicostata*. Chapm.; *Cytheropteron batesfordiense*, Chapm.<br>Pisces.—Fish remains, indet.; otoliths of teleosteans. |

### Notes on Bore No. 10.

This bore shows a reversion to corresponding depths to those at which the Kalimnan is reached in Bore 8; whilst Bore 9 indicates a much greater thickness of Pleistocene deposits. At 160-186 feet the pebbly and micaceous shell-sand contains a varied fauna, indicating a shallow estuarine and marine deposit in which typical Kalimnan fossils occur, such as *Mactra axiniformis* and *Liopyrga quadricingulata*.

The enormous *Natica* shell recorded from 220 feet was a fortuitous occurrence, as the shell had escaped comminution by being wedged into the boring auger. Its presence indicates extremely favorable life conditions, and a sandy, moderately-shallow water habitat.

The green, micaceous clay met with at 225–230 feet, besides containing a typical Kalimnan assemblage, is especially remarkable for the great quantity of foraminiferal shells belonging to *Rotalia beccarii*, and which clearly indicates estuarine conditions. The Kalimnan persists to 254 feet.

At 254–296 feet we have the first indications of Janjukian fossils, as *Ditrupa cornea*, var. *wormbetiensis* and *Graphularia*. This older facies is further augmented at 310–320 feet by the numerous polyzoa of Janjukian age, as well as the ostracod *Cytheropteron batesfordiense*. This bore terminates therefore with a mixed Janjukian and Kalimnan fauna.

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BORE No. 11.

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| Surface–1 | Brown loamy sand | |
| 1–28 .. | Pinkish concretionary limestone | Containing a few grains of quartz. |
| 28–45 .. | White sand .. .. | Sub-angular grains |
| 45–130 .. | Brown sand .. .. | Grains rounded or sub-angular, some well polished. |
| 130–148 .. | Grey sand and pebbles | Sub-angular to rounded grains; pebbles well water-worn. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 148–170 .. | Tea-green sand, with mica flakes | Minute organisms present, indicative of shallow marine or brackish-water conditions.<br>Foraminifera.—*Frondicularia complanata*, Defr.; *Discorbina araucana*, d'Orb. sp.; *Pulvinulina repanda*, F. and M. sp.; *Rotalia beccarii*, L. sp.; *Polystomella macella*, F. and M. sp.; *P. crispa*, L. sp.<br>Spongiae.—A triradiate calcareous sponge spicule, indet.<br>Echinodermata.—Echinoid spines, indet. |
| 170–175 .. | Tea-green sandy clay .. | Foraminifera.—*Miliolina seminulum*, L. sp.; *Polymorphina elegantissima*, P. and J.; *Rotalia beccarii*, L. sp.; *Nonionina depressula*, W. and J. sp.; *Polystomella striatopunctata*, F. and M. sp.; *P. crispa*, L. sp.<br>Spongiae.—Spicules of a calcisponge.<br>Echinodermata.—Echinoid spines and plates, indet.<br>Ostracoda.—*Cythere rastromarginata*, G.S.B. |
| 175–197 .. | Green sand .. .. | Foraminifera.—*Lagena schlichti*, A. Silvestri; *Patellina corrugata*, Will.; *Rotalia beccarii*, L. sp.; *Nonionina boueana*, d'Orb. sp.; *Polystomella craticulata*, F. and M. sp.; *P. crispa*, L. sp.<br>Spongiae.—Calcareous sponge spicules.<br>Echinodermata.—Echinoid spines and plates, indet.<br>Pelecypoda.—*Cuna concentrica*, Hedley; *Condylocardia tenuicostæ*, Chapm. and Gabr.<br>Scaphopoda.—*Cadulus acuminatus*, Tate.<br>Ostracoda.—*Xestoleberis setigera*, G. S. B.; *Cytherura capillifera*, Chapm.; *Cytherella subtruncata*, Chapm.; *C. pulchra*, G. S. B. |
| 197–199 .. | Clay, with shells .. | Foraminifera.—*Miliolina seminulum*, L. sp.; *M. vulgaris*, d'Orb. sp.; *M. schreiberiana*, d'Orb. sp.; *M. trigonula*, Lam. sp.; *M. (Massilina) secans*, d'Orb. sp.; *Nodosaria raphanus*, L. sp.; *Polymorphina communis*, d'Orb.; *P. oblonga*, d'Orb.; *P. regina*, B. P. and J.; *P. elegantissima*, P. and J.; *Sagraina striata*, Schwager; *Rotalia clathrata*, Brady; *Nonionina boueana*, d'Orb.; *Polystomella crispa*, L. sp.; *P. craticulata*, F. and M. sp.; *Operculina complanata*, Defr., var. *granulosa*, Ley.<br>Anthozoa.—*Holcotrochus crenulatus*, Denn.; *Bathyactis beaumariensis*, Denn.; *Notophyllia variolaris*, Denn.<br>Echinodermata.—*Pentagonaster* sp.; echinoid spines and plates, indet.<br>Polyzoa.—*Cellaria australis*, MacGill.; *Selenaria marginata*, T. W., var. *lucens*, MacG.<br>Pelecypoda.—*Nucula morundiana*, Tate; *Cardita pecten*, Tate; *C. calva*, Tate; *Cuna polita*, Tate sp.; *Cuna concentrica*, Hedley; *Condylocardia tenuicostæ*, Chapm. and Gabr.; *Crassatellites communis*, Tate sp.; *Erycina micans*, Tate sp.; *Dosinea greyi*, Zittel; *Mactra hamiltonensis*, Tate; *Psammobia aequalis*, Tate.<br>Scaphopoda.—*Cadulus acuminatus*, Tate.<br>Gasteropoda.—*Pyramidella jonesiana*, Tate sp.; *Bullinella aratula*, Cossm.<br>Crustacea.—*Cytherella pulchra*, G. S. B.; *Balanus varians*, Sow. |

## Details of Bores Nos. 1 to 11, etc. *continued.*

Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 199–209 .. | Green sand, with rotten shells | Foraminifera.—*Miliolina seminulum*, L. sp.; *Polymorphina oblonga*, d'Orb.; *P. elegantissima*, P. and J.; *P. communis*, d'Orb.; *Truncatulina refulgens*, Montf. sp.; *Rotalia clathrata*, Brady; *R. beccarii*, L. sp.; *Polystomella striatopunctata*, F. and M. sp.; *P. crispa*, L. sp.<br>Echinodermata.—Fragments of echinoid tests, indet.<br>Polyzoa.—*Cellaria australis*, MacGill.; *Selenaria marginata*, T. W., var. *lucens*, McG.; *S. marginata*, var. *spiralis*, Chapm.<br>Pelecypoda.—*Corbula ephamilla*, Tate.<br>Crustacea.—*Cythere rastromarginata*, G.S.B.; *Balanus* sp. |
| 209–219 .. | Hard glauconitic sandstone with concretions | Glauconitic casts of foraminifera. |
| 219–260 .. | Greenish glauconitic clay | Residue, after washing, chiefly fine calcareous sand and glauconitic casts.<br>Foraminifera.—*Bulimina elegantissima*, d'Orb.<br>Echinodermata.—Echinoid spines, indet.<br>Ostracoda.—*Cythere canaliculata*, Rss. sp.; *C. rastromarginata*, G. S. B.; *C. dictyon*, G. S. B.; *Cytherella pulchra*, G. S. B.; *C. auriculus*, Chapm. |
| 260–265 .. | Greenish sandy clay, with rotten shells | Foraminifera.—*Truncatulina ungeriana*, d'Orb. sp.; *Pulvinulina elegans*, d'Orb. sp.; *P. auricula*, F. and M. sp.<br>Echinodermata.—Echinoid spines, indet.<br>Ostracoda.—*Bairdia australis*, Chapm.; *Cythere militaris*, G. S. B. sp.; *C. lubbockiana*, G. S. B.; *C. canaliculata*, Rss. sp.; *C. dictyon*, G. S. B.; *Krithe eggeri*, Chapm. |
| 265–267 .. | Hard, yellow, arenaceous limestone | Organic remains, indet. |
| 267–270 .. | Whitish calcareous clay | Foraminifera.—*Miliolina* sp. (cast in glauconite); *Trillina howchini*, Schl.; *Cassidulina subglobosa*, Brady; *Cristellaria cultrata*, Montf. sp.; *Polymorphina elegantissima*, P. and J.; *Discorbina parisiensis*, d'Orb. sp.; *Truncatulina ungeriana*, d'Orb. sp.; *Rotalia clathrata*, Brady; *Polystomella craticulata*, F. and M. sp.; *P. verriculata*, Brady; *Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—Echinoid spines, indet.<br>Polyzoa.—*Cellaria* sp.<br>Ostracoda.—*Cythere dictyon*, G. S. B.; *C. ovalis*, G. S. B.; *Xestoleberis variegata*, G. S. B.; *X. margaritea*, G.S.B. sp.; *Cytherura ouyenensis*, Chapm.; *Cytheropteron rostratum*, Chapm.; *Cytherella punctata*, G. S. B. |
| 270–272 .. | Pale yellow calcareous sandstone | Containing a few shells, badly preserved. |
| 272–315 | Hard mortar-like limestone | Foraminifera.—*Polymorphina dispar*, Stache; *Truncatulina ungeriana*, d'Orb. sp.; *Pulvinulina* (?) *elegans*, d'Orb. sp.<br>Vermes.—*Ditrupa cornea*, L. sp. var. *wormbetiensis*, McCoy.<br>Polyzoa.—*Cellaria* sp.<br>Ostracoda.—*Cythere dictyon*, G. S. B. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 315–321 .. | Whitish marly clay .. | Foraminifera. — *Polymorphina communis*, d'Orb.; *Truncatulina lobatula*, W. and J. sp.; *T. ungeriana*, d'Orb. sp; *T. reticulata*, Cz. sp.; *Anomalina ammonoides*, Rss. sp.; *Pulvinulina elegans*, var. *partschiana*, d'Orb. var.; *Rotalia clathrata*, Brady; *Polystomella verriculata*, Brady; *P. craticulata*, F. and M. sp.; *Amphistegina lessonii*, d'Orb. sp.; *Operculina complanata*, Defr., var. *granulosa*, Ley.<br>Echinodermata.—Echinoid spines, indet. |
| 321–331 .. | Hard, cavernous, white limestone, with impressions of shells | Polyzoa.—(?) *Cellepora*.<br>Pelecypoda.—*Cardita latissima*, Tate.<br>Gasteropoda.—*Turritella tristira*, Tate. |
| 331–342 .. | Cavernous limestones, with worm-tubes and polyzoa | Foraminifera.—*Orbitolites complanata*, Lam.; *Amphistegina lessonii*, d'Orb.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy.<br>Polyzoa.—Spp. indet. |
| 345 .. | No rock sample .. | *Psammechinus iwoodsi*, Laube sp.; a large example of thns echinoderm, measuring 27 mm. in diameter and 17 mm. in height. |
| 342–349 .. | Stiff, whitish, marly clay | Foraminifera.—*Sigmoïlina schlumbergeri*, Silv.; *Nodosaria scalaris*, Batch sp.; *Bulumina elegantissima*, d'Orb.; *Polymorphina communis*, d'Orb.; *P. problema*, d'Orb.; *P. rotundata*, Born. sp.; *P. regina*, B. P. and J.; *P. elegantissima*, P. and J.; *Globigerina triloba*, Rss.; *Truncatulina lobatula*, W. and J. sp.; *T. ungeriana*, d'Orb. sp.; *T. reticulata*, Cz. sp.; *Pulvinulina elegans*, d'Orb. sp.; *Rotalia clathrata*, Brady; *Gypsina vesicularis*, P. and J.; *Polystomell a craticulata*, F. and M. sp.; *P. verriculata*, Brady.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.; *M. hamiltoni*, Thomson sp.<br>Echinodermata.—Echinoid spines, indet.; Crinoid ossicles.<br>Vermes.—*Ditrupa cornea*, L. sp. var. *wormbetiensis*, McCoy.<br>Polyzoa.—*Cellaria australis*, MacGill.; *C. rigida*, MacGill.; *Cellepora* sp.; *Bipora philippinensis*, Busk sp.<br>Ostracoda.—*Bythocypris tumefacta*, Chapm.; *Cythere postdeclivis*, Chapm. |
| 349–353 .. | Fine sandy limestone, of varying hardness | Foraminifera.—*Lagena schlichti*, Silv.; *Discorbina pileolus*, d'Orb. sp.; *Truncatulina lobatula*, W. and J. sp.; *Anomalina ammonoides*, Rss. sp.; *Rotalia clathrata*, Brady; *Polystomella craticulata*, F. and M. sp.<br>Ostracoda.—*Cytherella pulchra*, G. S. B. |
| 353–370 .. | A slate-coloured clay, with whitish streaks | Foraminifera.—*Bolivina textilarioides*, Rss.; *Nodosaria* (*Dentalina*) *obliqua*, L. sp.; *N.* (*D.*) *consobrina*, d'Orb.; *Cristellaria cultrata*, Montf. sp.; *C. rotulata*, Lam. sp.; *Polymorphina elegantissima*, P. and J.; *P. communis*, d'Orb.; *Discorbina biconcava*, P. and J.; *Truncatulina ungeriana*, d'Orb. sp.; *T. lobatula*, W. and J. sp.; *T. variabilis*, d'Orb.; *T. wuellerstorfi*, Schw. sp.; *Anomalina ammonoides*, Rss. sp.; *Nonionina umbilicatula*, Mont. sp.; *Operculina complanata*, Defr., var. *granulosa*, Ley.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy.<br>Polyzoa.—*Hornera*, sp. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 404 .. | No rock sample .. | Echinodermata.—*Echinocyamus* (*Scutellina*) *patella*, Tate sp.<br>Brachiopoda.—*Terebratulina catinuliformis*, Tate. |
| 406 .. | No rock sample .. | Brachiopoda.—*Magellania insolita*, Tate. |
| 430–432 .. | White, rubbly limestone, with much polyzoa | Foraminifera.—*Planispirina sphaera*, d'Orb. sp.; *Spiroplecta gramen*, d'Orb. sp.; *S. sagittula*, Defr. sp.; *Bulimina contraria*, Rss. sp.; *Cassidulina subglobosa*, Brady; *Nodosaria scalaris*, Batsch sp.; *N.* (*Dentalina*) *pauperata*, d'Orb. sp.; *N.* (*D*). *obliqua*, L. sp.; *Cristellaria rotulata*, Lam. sp.; *Polymorphina elegantissima*, P. and J.; *P. dispar*, Stache; *Globigerina triloba*, Rss.; *Truncatulina wuellerstorfi*, Schw. sp.; *T. haidingeri*, d'Orb. sp.; *T. lobatula*, W. and J. sp.; *T. ungeriana*, d'Orb. sp.; *Pulvinulina repanda*, F. and M. sp. var. *concamerata*, Mont. var.; *Rotalia calcar*, d'Orb.; *R. clathrata*, Brady; *Gypsina globulus*, Rss. sp.; *Polystomella craticulata*, F. and M. sp.; *P. verriculata*, Brady; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea* (?) *hamiltoni*, Thoms. sp.<br>Echinodermata.—*Antedon* sp. (centro-dorsals and arm ossicles); *Pentagonaster* sp.; Cidarid spines; *Paradoxechinus novus*, Laube sp.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.; *Fibularia gregata*, Tate; echinoid spines, indet.<br>Polyzoa.—*Cellaria australis*, MacGill.; *C. contigua*, MacGill.; *Macropora clarkei*, T. W. sp.; *Steganoporella magnilabris*, Busk sp.; *Cellepora fossa*, Hasw, sp.; (?) *Lekythopora* sp.; *Bipora philippinensis*, Busk sp.; *Idmonea* (?) *hochstetteriana*, Stol. sp.<br>Brachiopoda.—*Terebratella acutirostra*, sp. nov.; *Terebratulina triangularis*, Tate.<br>Ostracoda.—*Cythere scabrocuneata*, G. S. B. |
| 432–434 .. | Calcareous, gritty deposit; fossils much worn | Foraminifera.—*Virgulina schreibersiana*, Cz.; *Cassidulina subglobosa*, Brady; *Polymorphina gibba*, d'Orb.; *P. elegantissima*, P. and J.; *Discorbina turbo*, d'Orb. sp.; *D. obtusa*, d'Orb. sp.; *Truncatulina ungeriana*, d'Orb. sp.; *Pulvinulina schreibersii*, d'Orb. sp.; *Polystomella craticulata*, F. and M. sp.; *P. verriculata*, Brady; *Amphistegina lessonii*, d'Orb. sp.; *Operculina complanata*, Defr.<br>Echinodermata.—*Antedon* sp. (arm ossicles; echinoid spines, indet.).<br>Polyzoa.—*Cellaria australis*, MacGill.; *Steganoporella magnilabris*, Busk sp.; *Cellepora fossa*, Hasw. sp. |
| 434–436 .. | Hard, white, gritty limestone, with foraminifera, corals and polyzoa | Foraminifera.—*Amphistegina lessonii*, d'Orb.<br>Polyzoa.—*Porina gracilis*, M. Edw. sp.; *Cellaria* sp. |
| 436–438 .. | Hard white limestone, with polyzoa | Pelecypoda.—(?) *Pecten* sp. (impression). |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 438–440 .. | Soft calcareous deposit.. | Plantae.—*Lithothamnion ramosissimum,* Rss. sp.<br><br>Foraminifera.—*Spiroplecta sagittula,* Defr. sp.; *Bolivina limbata,* Brady; *Cassidulina subglobosa,* Brady; *Nodosaria* (*Dentalina*) *pauperata,* d'Orb. sp.; *N.* (*D.*) *obliqua,* L. sp.; *N.* (*D.*) *soluta,* Rss.; *Frondicularia inaequalis,* Costa; *F. lorifera,* Chapm.; *Polymorphina communis,* d'Orb.; *P. problema,* d'Orb.; *P. dispar,* Stache; *P. regina,* B. P. and J.; *P. elegantissima,* P. and J.; *P. rotundata,* Born. sp.; *Globigerina conglobata,* Brady; *G. triloba,* Rss.; *Discorbina obtusa,* d'Orb. sp.; *Truncatulina reticulata,* Cz. sp.; *T. lobatula,* W. and J. sp.; *T. ungeriana,* d'Orb. sp.; *Nonionina umbilicatula,* Mont. sp.; *Polystomella craticulata,* F. and M. sp.; *P. verriculata,* Brady; *Amphistegina lessonii,* d'Orb.<br><br>Anthozoa.—*Mopsea tenisoni,* Chapm.<br><br>Echinodermata.—*Antedon* sp. (ossicles); echinoid plates, indet.; *Pentagonaster* sp.<br><br>Polyzoa.—*Cellepora* sp.; *Cellaria* sp.<br><br>Brachiopoda.—*Terebratulina catinuliformis,* Tate.<br><br>Ostracoda.—*Cythere postdeclivis,* Chapm.; *C. dictyon,* G. S. B.; *Cytheropteron batesfordiense,* Chapm. |
| 440–442 .. | Soft calcareous deposit.. | Foraminifera.—*Gaudryina rugosa,* d'Orb.; *Cassidulina subglobosa,* Brady; *Frondicularia inaequalis,* Costa; *Polymorphina dispar,* Stache; *P. elegantissima,* P. and J.; *Globigerina bulloides,* d'Orb.; *G. conglobata,* Brady; *Planorbulina larvata,* P. and J.; *Truncatulina lobatula,* W. and J. sp.; *Anomalina ammonoides,* Rss. sp.; *Pulvinulina elegans,* d'Orb. sp.; *Rotalia calcar,* d'Orb.; *R. papillosa,* var. *compressiuscula,* Brady; *Gypsina howchini,* Chapm.; *Nonionina depressula,* W. and J. sp.; *Polystomella craticulata,* F. and M. sp.; *P. verriculata,* Brady; *Amphistegina lessonii,* d'Orb.; *Operculina complanata,* Defr.<br><br>Echinodermata.—Echinoid fragments (indet.); *Antedon* sp. (ossicles).<br><br>Polyzoa.—*Cellepora fossa,* Hasw. sp.; (?) *Lekythopora* sp.; *Idmonea* sp.; *Entalophora* sp.<br><br>Brachiopoda.—*Magasella* sp., indet.<br><br>Ostracoda.—*Cythere postdeclivis,* Chapm.; *Cytheropteron batesfordiense,* Chapm. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 442–444 .. | A soft chalky deposit .. | Foraminifera.—*Verneuilina spinulosa*, Rss.; *Bulimina elegans*, d'Orb.; *Bolivina punctata*, d'Orb.; *Cassidulina subglobosa*, Brady; *Nodosaria* (*Dentalina*) *obliqua*, L. sp.; *Frondicularia inaequalis*, Costa; *Marginulina costata*, Batsch. sp.; *Cristellaria tricarinella*, Rss.; *Polymorphina regina*, B. P. and J.; *P. dispar*, Stache; *P. elegantissima*, P. and J.; *Globigerina triloba*, Rss.; *Discorbina bertheloti*, d'Orb. sp.; *Planobulina larvata*, P. and J.; *Truncatulina lobatula*, W. and J. sp.; *T. ungeriana*, d'Orb. sp.; *T. reticulata*, Cz. sp.; *T. refulgens*, Montf. sp.; *Anomalina ammonoides*, Rss. sp.; *Polystomella verriculata*, Brady; *P. craticulata*, F. and M. sp.; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.<br>Spongiae.—Calcareous spicules, indet.<br>Anthozoa.—*Mopsea hamiltoni*, Thoms. sp.<br>Echinodermata.—*Pentagonaster* sp.; (?) *Antedon* sp. (ossicles); echinoid test-fragments, indet.<br>Polyzoa.—*Cellaria contigua*, MacGill.; *Cellepora* sp.; *Porina gracilis*, M. Edw. sp.; *Lichenopora radiata*, Audrouin sp.; *Hornera* sp.<br>Brachiopoda.—*Magasella* sp., indet.; *Terebratulina catinuliformis*, Tate; *T. triangularis*, Tate.<br>Ostracoda.—*Cythere postdeclivis*, Chapm.; *C. scabrocuneata*, G. S. B.; *C. lactea*, G. S. B.; *C. obtusalata*, G. S. B.; *C. scutigera*, G. S. B.; *Cytheropteron batesfordiense*, Chapm. |
| 444–446 .. | A soft chalky deposit .. | Foraminifera.—*Gaudryina rugosa*, d'Orb.; *Cassidulina subglobosa*, Brady; *Polymorphina dispar*, Stache; *P. regina*, B. P. and J.; *P. elegantissima*, P. and J.; *P. lactea*, W. and J. sp.; *P. rotundata*, Born, sp.; *Globigerina bulloides*, d'Orb.; *Truncatulina reticulata*, Cz. sp.; *T. ungeriana*, d'Orb. sp.; *Pulvinulina repanda*, F. and M. sp.; *Rotalia orbicularis*, d'Orb.; *Nonionina depressula*, W. and J. sp.; *Polystomella verriculata*, Brady; *P. craticulata*, F. and M. sp.; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.<br>Spongiae.—Spicules of calcareous sponges, indet.<br>Anthozoa.—*Mopsea hamiltoni*, Thoms. sp.<br>Echinodermata.—*Antedon* sp.; echinoid plates and spines, indet.<br>Polyzoa.—Numerous but badly preserved; *Cellaria rigida*, MacGill.; *Cellepora fossa*, Hasw. sp.; *Bipora philippinensis*, Busk. sp.; *Idmonea* spp.<br>Brachiopoda.—Brachiopoda fragments, indet.<br>Ostracoda.—*Cythere scabrocuneata*, G. S. B.; *C. normani*, G. S. B.; *Loxoconcha australis*, G. S. B.; *Cytheropteron batesfordiense*, Chapm. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 446–448 .. | Soft, friable, chalky limestone | Foraminifera.—*Bolivina nobilis*, Hantk.; *Nodosaria* (*Dentalina*) *obliqua*, L. sp.; *N.* (*D.*) *multilineata*, Born. sp.; *Frondicularia inaequalis*, Costa; *Marginulina costata*, Batsch sp.; *Polymorphina dispar*, Stache; *P. elegantissima*, P. and J.; *P. communis*, d'Orb.; *P. gibba*, d'Orb.; *P. regina*, B. P. and J.; *Globigerina conglobata*, Brady; *Truncatulina lobatula*, W. and J. sp.; *T. ungeriana*, d'Orb. sp.; *Nonionina depressula*, W. and J. sp.; *Polystomella verriculata*, Brady; *P. craticulata*, F. and M. sp.; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—(?) *Antedon* sp.; *Pentagonaster* sp.; echinoid plates and spines.<br>Polyzoa.—*Cellaria* sp.; *Hornera* sp.<br>Brachiopoda.—*Terebratulina catinuliformis* Tate.<br>Ostracoda.—*Cythere postdeclivis*, Chapm.; *C. normani*, G. S. B.; *C. scabrocuneata*, G. S. B.; *C. lubbockiana*, G. S. B.; *Cythere obtusalata*, G. S. B.; *Cytheropteron batesfordiense*, Chapm.<br>Pisces.—Fish otolith (teleostean). |
| 448–450 .. | Soft, chalky limestone. Organisms not well preserved | Foraminifera.—*Gaudryina rugosa*, d'Orb.; *Bolivina limbata*, Brady; *Cassidulina subglobosa*, Brady; *Polymorphina elegantissima*, P. and J.; *P. dispar*, Stache; *Globigerina bulloides*, d'Orb.; *Discorbina pileolus*, d'Orb. sp.; *Truncatulina ungeriana*, d'Orb. sp.; *T. reticulata*, Cz. sp.; *Pulvinulina elegans*, d'Orb. sp.; *Rotalia clathrata*, Brady; *Polystomella craticulata*, F. and M. sp.; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.<br>Echinodermata.—Echinoid plates, indet.<br>Vermes.—*Ditrupa cornea*, L. sp., var. *wormbetiensis*, McCoy.<br>Polyzoa.—*Cellaria* spp.; *Lepralia* sp. |
| 450–452 .. | Soft, white earthy limestone | Foraminifera.—*Gaudryina rugosa*, d'Orb.; *Cassidulina subglobosa*, Brady; *C. oblonga*, Rss.; *Polymorphina elegantissima*, P. and J.; *P. regina*, B. P. and J.; *Sphæroidina bulloides*, d'Orb.; *Discorbina* (?) *obtusa*, d'Orb. sp.; *Truncatulina reticulata*, Cz. sp.; *T. ungeriana*, d'Orb. sp.; *Anomalina* (?) *ammonoides*, Rss. sp.; *Polystomella verriculata*, Brady; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr., and var. *granulosa*, Ley.<br>Polyzoa.—*Cellaria rigida*, MacGill.; *Porina gracilis*, McG.; *Bipora philippinensis*, Busk sp.<br>Ostracoda.—*Bythocypris tumefacta*, Chapm. |
| 453–454 .. | White, finely granular limestone | Foraminifera.—*Cassidulina subglobosa*, Brady; *Globigerina bulloides*, d'Orb.; *Truncatulina tenera*, Brady; *T. ungeriana*, d'Orb. sp.; *Rotalia clathrata*, Brady; *Polystomella craticulata*, F. and M. sp.; *P. crispa*, L. sp.; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.<br>Polyzoa.—*Cellaria rigida*, MacGill.<br>Ostracoda.—*Cytheropteron batesfordiense*, var. *aculeata*, Chapm. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 454–456 .. | White granular limestone | No fossils found. |
| 456–457 .. | White rubbly limestone | Polyzoan remains common, but badly preserved. |
| 457–458 .. | Soft chalky limestone .. | Plantae.—*Lithothamnion ramosissimum*, Rss. sp.; *L.* aff. *lichenoides*, Ellis. and Sol.<br>Foraminifera.—*Cassidulina subglobosa*, Brady; *Marginulina glabra*, d'Orb.; *Vaginulina legumen*, L. sp.; *Cristellaria cultrata*, Montf. sp.; *Polymorphina dispar*, Stache; *P. elegantissima*, P. and J.; *P. regina*, B. P. and J.; *P. gibba*, d'Orb.; *Sagraina raphanus*, P. and J.; *Globigerina triloba*, Rss.; *Truncatulina reticulata*, Cz. sp.; *T. ungeriana*, d'Orb. sp.; *T. haidingeri*, d'Orb. sp.; *Pulvinulina truncatulinoides*, d'Orb. sp.; *Rotalia clathrata*, Brady; *Polystomella craticulata*, F. and M. sp.; *P. verriculata*, Brady; *Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.; *M.* (?) *hamiltoni*, Thoms. sp.<br>Echinodermata.—(?) *Antedon* sp.; echinoid plates and spines, indet.<br>Polyzoa.—*Cellaria* sp.<br>Ostracoda.—*Macrocypris tumida*, G. S. B.; *Cythere postdeclivis*, Chapm.; *C. scabrocuneata*, G. S. B.; *C. dictyon*, G. S. B.; *Cytheropteron batesfordiense*, Chapm.; *Cytherella polita*, G. S. B. |
| 458–459 .. | White rubbly limestone | Polyzoa and mollusca present, the latter as casts. *Cellepora* sp. (massive form). |
| 459–460 .. | White to grey rubbly limestone | Foraminifera.—*Operculina complanata*, Defr.<br>Polyzoa.—*Cellaria* sp.; *Cellepora* sp. |
| 460 .. | Washed material .. | Echinodermata.—*Echinocyamus* (*Scutellina*) *patella*, Tate sp.; echinoid test fragments, indet.<br>Polyzoa.—*Cellaria contigua*, MacGill.; *Cellepora fossa*, Hasw. sp.<br>Brachiopoda.—*Magellania insolita*, Tate sp.; *Terebratulina catinuliformis*, Tate. |
| 460–465 .. | Washed material .. | Foraminifera.—*Operculina complanata*, Defr. var. *granulosa*, Ley.<br>Echinodermata.—*Echinoid spines*, indet.; *Arachnoides* (*Monostychia*) sp. (fragment).<br>Polyzoa.—Spp. indet. |
| 465–470 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—Fragments of echinoid tests, indet.<br>Polyzoa.—*Tessaradoma elevata*, Waters sp.; *Lepralia* sp.<br>Brachiopoda.—*Magasella woodsiana*, Tate.<br>Pelecypoda.—*Pecten præcursor*, Chapm.<br>Gasteropoda.—Casts, indet. |
| 470–475 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—Echinoid tests, indet.; cf. *Eupatagus* sp.<br>Polyzoa.—*Lepralia elongata*, MacGill.<br>Brachiopoda.—*Magasella woodsiana*, Tate; *Terebratulina catinuliformis*, Tate.<br>Pelecypoda.—Fragments of bivalves, indet. |
| 475–480 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—Fragments of echinoid tests, indet.<br>Polyzoa.—*Membranipora* cf. *fossa*, MacGill.; *Lepralia crassatina*, Waters sp. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 480–485 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—Echinoid test fragments, indet.<br>Polyzoa.—*Lepralia* cf. *graysoni*, MacGill.; *L. elongata*, MacGill.<br>Brachiopoda.—*Magasella woodsiana*, Tate. |
| 485–490 .. | Washed material .. | Foraminifera.—*Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster* sp.; *Psammechinus woodsi*, Laube sp.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.<br>Polyzoa.—*Cellaria rigida*, MacGill.; *Cellepora fossa*, Hasw. sp.; *Lichenopora porosa*, MacGill.<br>Brachiopoda.—*Magellania insolita*, Tate; *Terebratulina catinuliformis*, Tate.<br>Pelecypoda.—*Pecten polymorphoides*, Zittel. |
| 490–495 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster sp.*; *Psammechinus woodsi*, Laube sp.; *Echinoneus dennanti*, Hall; echinoid test fragments, indet.<br>Polyzoa.—*Cellepora fossa*, Hasw. sp.<br>Brachiopoda.—*Magellania insolita*, Tate; *Terebratulina catinuliformis*, Tate. |
| 495–500 .. | Washed material .. | Foraminifera.—*Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.; *Isis compressa*, Duncan.<br>Echinodermata.—Echinoid spines, indet.<br>Polyzoa.—*Tessaradoma elevata*, Waters sp.; *Lepralia corrugata*, MacGill.; *Macropora clarkei*, T. W. sp.; (?) *Lunulites* sp.; *Cellepora fossa*, Hasw. sp.<br>Brachiopoda.—*Magasella woodsiana*, Tate; *Terebratulina catinuliformis*, Tate; *Magellania insolita*, Tate (juv.). |
| 500–505 .. | Washed material .. | Foraminifera.—*Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—Echinoid spines, indet.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.<br>Polyzoa.—*Cellepora fossa*, Hasw. sp.; *Macropora clarkei*, T. W. sp.; *Lichenopora porosa*, MacGill.<br>Brachiopoda.—*Terebratulina catinuliformis*, Tate. |
| 505–510 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.; *M. hamiltoni*, Thoms. sp. (figd.).<br>Echinodermata.—Echinoid test fragments.<br>Polyzoa.—*Macropora clarkei*, T. W. sp.; *Cellepora fossa*, Hasw. sp.; *Steganoporella patula*, Waters sp.<br>Brachiopoda.—*Terebratella portlandica*, Chapm.; *Terebratulina catinuliformis*, Tate.<br>Pelecypoda.—*Pecten præcursor*, Chapm. |
| 510–515 .. | Washed material .. | Echinodermata.—*Echinocyamus* (*Scutellina*) *patella*, Tate sp.; fragments of echinoid tests, indet.<br>Polyzoa.—*Bipora philippinensis*, Busk sp.; *Cellepora fossa*, Hasw. sp.; *Lichenopora porosa*, MacGill.; *Retepora* sp.<br>Brachiopoda.—*Magellania insolita*, Tate.<br>Pelecypoda.—*Pecten præcursor*, Chapm.; *P. polymorphoides*, Zittel. |
| 515 .. | .. .. .. | Pisces.—(?) *Lamna apiculata*, Ag. sp. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 515–520 .. | Washed material .. | Foraminifera.—*Operculina complanata*, Defr., var. *granulosa*, Ley.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster* sp.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.; fragments of echinoid tests, indet.<br>Polyzoa.—*Cellaria* sp.; *Cellepora fossa*, Hasw. sp.; *C. tridenticulata*, var. *nummularia*, Busk (in T. W.).<br>Brachiopoda.—*Magellania insolita*, Tate; *Terebratella portlandica*, Chapm.<br>Pelecypoda.—*Pecten foulcheri*, T. W.; *P. præcursor*, Chapm.; *P. polymorphoides*, Zittel. |
| 520 .. | Fragment of white limestone | Polyzoa.—*Membranipora* sp.<br>Pelecypoda.—*Pecten* sp., indet. |
| 520–525 .. | Washed material .. | Echinodermata.—*Pentagonaster* sp.; *Lovenia forbesi*, W. and D. sp.<br>Polyzoa.—*Cellepora fossa*, Hasw. sp.; *C.* cf. *gambierensis*, Busk (in T. Woods); *Tessaradoma elevata*, Waters sp.; *Macropora clarkei*, T. W. sp.; *Microporella magna*, T. W. sp.; *Porina gracilis*, M. E. sp.<br>Pelecypoda.—*Pecten polymorphoides*, Zittel. |
| 525–530 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster* sp.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.<br>Polyzoa.—*Cellaria angustiloba*, Busk sp.; (?) *Schizoporella* sp.; *Cellepora fossa*, Hasw. sp.; *Porina gracilis*, M. Edw. sp.; *Tessaradoma magnirostris*, MacGill.; *Retepora* sp.; *Lichenopora porosa*, MacGill.<br>Brachiopoda. — *Terebratella portlandica*, Chapm.<br>Pelecypoda.—*Pecten foulcheri*, T. W.; *P. polymorphoides*, Zittel.<br>Gasteropoda.—Cf. *Turritella* (cast); gasteropod cast, indet. |
| 530 .. | .. .. .. | Chela of crab, indet. |
| 530–535 .. | Washed material .. | Foraminifera.—*Operculina complanata*, Defr.<br>Echinodermata.—*Pentagonaster* sp.; *Goniocidaris* sp. (spine); *Echinocyamus* (*Scutellina*) *patella*, Tate sp.<br>Polyzoa.—*Tessaradoma elevata*, Waters sp.; *T. magnirostris*, MacGill.; *Macropora clarkei*, T. W. sp.; *Cellepora fossa*, Hasw. sp.<br>Brachiopoda.—*Terebratulina catinuliformis*, Tate. |
| 535–540 .. | Washed material .. | Echinodermata.—*Pentagonaster* sp.; (?) *Cidaris* sp.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.<br>Polyzoa.—*Tessaradoma elevata*, Waters sp.; *T. magnirostris*, MacGill.; *Cellepora fossa*, Hasw. sp.; *Cellepora* sp., indet.; *Retepora* sp.; *Lichenopora* sp.<br>Brachiopoda.—*Magellania insolita*, Tate; *Terebratulina catinuliformis*, Tate.<br>Pelecypoda.—*Lima* (*Limatula*) *jeffreysiana*, Tate. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 540–545 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Cidaris* sp.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.<br>Polyzoa.—*Tessaradoma elevata*, Waters sp.; *T. magnirostris*, MacGill.; *Cellepora gambierensis*, Busk (in T. Woods).<br>Brachiopoda.—*Magellania insolita*, Tate; *Terebratulina catinuliformis*, Tate.<br>Pelecypoda.—*Pecten polymorphoides*, Zittel; *P.gambierensis*, T. W. |
| 540–542 .. | White, calcareous, sandy rock | Foraminifera.—*Gaudryina rugosa*, d'Orb.; *Spiroplecta gramen*, d'Orb. sp.; *Bolivina limbata*, Brady; *Cassidulina subglobosa*, Brady; *Lagena schlichti*, A. Silv.; *Nodosaria* (*D.*) *obliqua*, L. sp.; *N.* (*D.*) cf. *soluta*, Rss.; *Marginulina glabra*, d'Orb.; *Cristellaria aculeata*, d'Orb.; *Polystomella elegantissima*, P. and J.; *Globigerina triloba*, Rss.; *Carpenteria proteiformis*, Goës (juv.); *Pulvinulina elegans*, d'Orb. sp.; *P. exigua*, Brady; *P. truncatulinoides*, d'Orb. sp.; *P. scabricula*, Chapm.; *Rotalia clathrata*, Brady; *Nonionina umbilicatula*, Mont. sp.; *Polystomella verriculata*, Brady; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—(?) *Antedon* sp. (arm ossicles); *Pentagonaster* sp.; echinoid spines, indet.<br>Polyzoa.—*Cellaria rigida*, MacGill.; *C. contigua*, MacGill.; *Cellepora fossa*, Hasw. sp.; *Retepora producta*, Busk.<br>Ostracoda.—*Macrocypris tumida*, G. S. B.; *Bairdia australis*, Chapm.; *Bythocypris tumefacta*, Chapm.; *Cythere lubbockiana*, G. S. B.; *C. postdeclivis*, Chapm.; *Cytherella pulchra*, G. S. B. |
| 542–544 .. | White clacareous marl, very friable | Foraminifera.—*Cassidulina subglobosa*, Brady; *Nodosaria* (*D.*) *obliqua*, L. sp.; *Marginulina costata*, Batsch sp.; *Polymorphina elegantissima*, P. and J.; *P. dispar*, Stache; *Globigerina triloba*, Rss.; *Truncatulina refulgens*, Montf. sp.; *T. ungeriana*, d'Orb. sp.; *Pulvinulina elegans*, d'Orb. sp.; *Polystomella crispa*, L. sp.; *P. verriculata*, Brady; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr., and var. *granulosa*, Ley.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster* sp.; cidaroid plates, indet.<br>Polyzoa.—*Cellaria angustiloba*, Busk sp.; *C. contigua*, MacGill.; *C.* cf. *rigida*, MacGill.; *Cellepora fossa*, Hasw. sp.; *Bipora philippinensis*, Busk sp.<br>Pelecypoda. — *Rochefortia donaciformis*, Angas sp.<br>Ostracoda.—*Macrocypris decora*, G. S. B. sp.; *M. tumida*, G. S. B.; *Bairdia amygdaloides*, G. S. B.; *B. australis*, Chapm.; *Cythere postdeclivis*, Chapm. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 544–546 .. | Soft chalky limestone .. | Foraminifera.—*Cassidulina subglobosa*, Brady; *Polymorphina elegantissima*, P. and J.; *Globigerina triloba*, Rss.; *Discorbina dimidiata*, P. and J.; *D. turbo*, d'Orb. sp.; *Truncatulina wuellerstorfi*, Schw. sp.; *T. ungeriana*, d'Orb. sp.; *Carpenteria proteiformis*, Goës; *Pulvinulina elegans*, d'Orb. sp.; *Rotalia clathrata*, Brady; *R. calcar*, d'Orb. sp.; *Polystomella verriculata*, Brady; *Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—Echinoid spines, indet.<br>Polyzoa.—*Cellaria contigua*, MacGill.; *C. rigida*, MacGill.; *C. australis*, MacG.; *Lepralia burlingtoniensis*, Waters,; *Smittia tatei*, T. W. sp.; *Porina gracilis*, M. Edw. sp.<br>Pelecypoda. — *Rochefortia donaciformis*, Angas sp.<br>Ostracoda.—*Cythere postdeclivis*, Chapm.; *C. crispata*, G. S. B.; *C. scabrocuneata*, G. S. B. |
| 545–550 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster* sp.; echinoid spines and plates, indet.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.<br>Polyzoa.—*Cellaria rigida*, McG.; *Smittia tatei*, T. W. sp.; *Cellepora fossa*, Hasw. sp.; *C. gambierensis*, Busk (in T. Woods); *Porina gracilis*, M. Edws. sp.<br>Brachiopoda.—*Terebratula tateana*, T. W.; *Terebratella portlandica*, Chapm.; *Magellania garibaldiana*, Dav. sp.<br>Pelecypoda.—*Pecten foulcheri*, T. W.; *P. polymorphoides*, Zittel. |
| 546–548 .. | Soft chalky limestone .. | Foraminifera.—*Spiroplecta sagittula*, Defr. sp.; *Cassidulina subglobosa*, Brady; *Polymorphina elegantissima*, P. and J.; *P. dispar*, Stache; *Globigerina triloba*, Rss.; *Anomalina ammonoides*, Rss. sp.; *Pulvinulina elegans*, d'Orb. sp.; *Rotalia papillosa*, var. *compressiuscula*, Brady; *Rotalia clathrata*, Brady; *Polystomella verriculata*, Brady; *P. craticulata*, F. and M. sp.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—(?) *Antedon* sp. (arm ossicles); spines and plates of echinoids, indet.<br>Polyzoa.—*Cellaria rigida*, McG.; *C. contigua*, McG.; *Cellepora fossa*, Hasw. sp.<br>Brachiopoda.—*Terebratulina triangularis*, Tate.<br>Ostracoda.—*Bythocypris tumefacta*, Chapm.; *Cythere postdeclivis*, Chapm.; *C. canaliculata*, Rss. sp.; *Cytherella pulchra*, G. S. B. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 548–550 .. | Rubbly calcareous rock | Foraminifera.—*Spiroplecta gramen*, d'Orb. sp.; *Nodosaria (D.) obliqua*, L. sp.; *Polymorphina elegantissima*, P. and J.; *Globigerina triloba*, Rss.; *Truncatulina variabilis*, d'Orb.; *T. ungeriana*, d'Orb. sp.; *Rotalia papillosa*, var. *compressiuscula*, Brady; *Operculina complanata*, Defr.<br>Polyzoa.—*Cellaria contigua*, McG.; *C. rigida*, and var. *perampla*, Waters; *Smittia tatei*, T. W. sp.; *Entolaphora verticillata*, Goldf. sp.<br>Pelecypoda.—*Pecten foulcheri*, T. W.<br>Ostracoda.—*Bairdia tumefacta*, Chapm.; *B. australis*, Chapm.; *Cythere postdeclivis*, Chapm.; *C. canaliculata*, Rss. sp.; *Cytheropteron batesfordiense*, Chapm. |
| 550–552 .. | Rubbly calcareous rock | Foraminifera.—*Cassidulina subglobosa*, Brady; *Polymorphina regina*, B. P. and J.; *P. elegantissima*, P. and J.; *Globigerina triloba*, Rss. *Truncatulina reticulata*, Cz. sp.; *T. ungeriana*; d'Orb. sp.; *T. akneriana*, d'Orb. sp.; *T. lobatula*, W. and J. sp.; *Anomalina ammonoides*, Rss. sp.; *Pulvinulina elegans*, d'Orb. sp.<br>Polyzoa.—*Cellaria rigida*, McG.; *C. acutimarginata*, McG.; *C. angustiloba*, Busk sp. |
| 550–555 .. | Washed material .. | Echinodermata.—*Pentagonaster* sp.; echinoid spines, indet.<br>Polyzoa.—*Cellaria rigida*, McG.; *Cellepora, gambierensis*, Busk (in T. Woods); *C. fossa*, Hasw. sp.<br>Brachiopoda.—*Magellania garibaldiana*, Dav. sp.<br>Pelecypoda.—*Pecten polymorphoides*, Zittel.<br>Pisces.—Otoliths (teleostean). |
| 552–554 .. | Rubbly calcareous rock | Foraminifera.—*Miliolina oblonga*, Mont. sp.; *Spiroplecta gramen*, d'Orb. sp.; *Cassidulina subglobosa*, Brady; *Polymorphina elegantissima*, P. and J.; *P. problema*, d'Orb.; *Uvigerina angulosa*, Will.; *Globigerina triloba*, Rss.; *Truncatulina ungeriana*, d'Orb. sp.; *Pulvinulina elegans*, d'Orb. sp.; *P. schreibersi*, d'Orb. sp.; *Rotalia clathrata*, Brady; *Operculina complanata*, Defr.<br>Echinodermata.—Echinoid spines and plates, indet.<br>Polyzoa.—*Cellaria rigida*, McG., and var. *perampla*, Waters; *Entalophora verticillata*, Goldf. sp.<br>Ostracoda.—*Bythocypris tumefacta*, Chapm.; *Bairdia australis*, Chapm.; *Cythere dasyderma*, G. S. B.; *C. scabrocuneata*, G. S. B. |
| 554–556 .. | Rubbly calcareous rock | Foraminifera.—*Polymorphina dispar*, Stache; *Globigerina triloba*, Rss.; *Truncatulina ungeriana*, d'Orb. sp.; *Pulvinulina elegans*, d'Orb. sp.; *P. scabricula*, Chapm.; *Rotalia clathrata*, Brady; *Operculina complanata*, Defr.<br>Polyzoa.—*Cellaria rigida*, McG., and var. *perampla*, Waters; *Entalophora verticillata*, Goldf. sp.<br>Ostracoda.—*Bythocypris tumefacta*, Chapm.; *Bairdia australis*, Chapm.; *Cythere crispata*, G. S. B.; *C. dasyderma*, G. S. B.; *Cytherella pulchra*, G. S. B. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 555–560 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.; *Alcyonium*, indet.<br>Echinodermata.—*Pentagonaster* sp.; echinoid spines and plates, indet.<br>Polyzoa.—*Tessaradoma elevata*, Waters sp.; *T. magnirostris*, McG.; *Cellepora fossa*, Hasw. sp.; *Porina gracilis*, M. Edw. sp.<br>Brachiopoda.—*Magellania garibaldiana*, Dav. sp. |
| 556–558 .. | Soft calcareous sand-rock | Foraminifera.—*Bolivina nobilis*, Hantk.; *Cassidulina subglobosa*, Brady; *Nodosaria (D.) obliqua*, L. sp.; *Polymorphina elegantissima*, P. and J.; *P. gibba*, d'Orb.; *P. dispar*, Stache; *P. regina*, B. P. and J.; *Globigerina triloba*, Rss.; *Truncatulina ungeriana*, d'Orb. sp.; *T. refulgens*, Montf. sp.; *T. reticulata*, Cz. sp.; *Pulvinulina elegans*, d'Orb. sp.; *P. repanda*, F. and M. sp.; *Rotalia clathrata*, Brady; *R. orbicularis*, d'Orb.; *Polystomella verriculata*, Brady.<br>Echinodermata.—Echinoid spines, indet.<br>Polyzoa.—*Cellaria contigua*, McG.; *C. rigida*, McG.; *C. acutimarginata*, McG.; *C. angustiloba*, Busk sp.; *Porina gracilis*, M. Edw. sp.; *Entalophora verticillata*, Goldf. sp.<br>Ostracoda.—*Bythocypris tumefacta*, Chapm. |
| 558–560 .. | Soft calcareous sand-rock | Foraminifera.—*Cassidulina subglobosa*, Brady; *Frondicularia inæqualis*, Costa; *Marginulina costata*, Batsch sp.; *Polymorphina elegantissima*, P. and J.; *P. communis*, d'Orb.; *P. dispar*, Stache; *Globigerina triloba*, Rss.; *Truncatulina ungerina*, d'Orb. sp.; *Pulvinulina elegans*, d'Orb. sp.; *Polystomella craticulata*, F. and M. sp.; *P. verriculata*, Brady; *Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster* sp.; *Antedon* sp.; echinoid plates and spines, indet.<br>Polyzoa.—*Cellaria rigida*, McG. and var. *perampla*, Waters; *C. acutimarginata*, McG.; *C. angustiloba*, Busk sp.; *Porina gracilis*, M. Edw. sp.; *Entalophora verticillata*, Goldf. sp.<br>Pelecypoda.—*Pecten foulcheri*, T. W.<br>Ostracoda.—*Bythocypris tumefacta*, Chapm.; *Cytherella pulchra*, G. S. B. |
| 560–565 .. | Washed material .. | Foraminifera.—*Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster* sp.; *Fibularia gregata*, Tate; echinoid plates and spines.<br>Polyzoa.—*Cellaria rigida*, McG.; *Cellepora tridenticulata*, var. *nummularia*, Busk; *Porina gracilis*, M. Edw. sp.; *Lichenopora porosa*, McG.<br>Brachiopoda.—*Magasella lunata*, Tate. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 560–562 .. | Soft calcareous sand-rock | Foraminifera.—*Cassidulina subglobosa*, Brady; *Polymorphina elegantissima*, P. and J.; *P. dispar*, Stache; *Globigerina triloba*, Rss.; *Truncatulina reticulata*, Cz. sp.; *Carpenteria proteiformis*, Goës (juv.); *Pulvinulina elegans*, d'Orb. sp.; *Polystomella verriculata*, Brady; *Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—(?) *Antedon* spp. (arm ossicles and cirrus joint); echinoid plates and spines, indet.<br>Polyzoa.—*Cellaria rigida*, McG., var. *perampla*, Waters; *C. contigua*, McG.; *C. acutimarginata*, McG.; (?) *Schismopora costazei*, Aud. sp.; *Bipora philippinensis*, Busk sp.; *Porina gracilis*, M. Edw. sp.; *Lichenopora porosa*, McG. |
| 562–564 .. | Soft calcareous sand-rock | Foraminifera.—*Spiroplecta gramen*, d'Orb. sp.; *Cassidulina subglobosa*, Brady; *Polymorphina elegantissima*, P. and J.; *Truncatulina wuellerstorfi*, Schw. sp.; *T. haidingeri*, d'Orb. sp.; *Anomalina ammonoides*, Rss. sp.; *Pulvinulina karsteni*, Rss. sp.; *P. elegans*, d'Orb. sp., and var. *partschiana*, d'Orb. var.; *Rotalia clathrata*, Brady; *Polystomella craticulata*, F. and M. sp.; *P. verriculata*, Brady; *P. crispa*, L. sp.; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr.<br>Anthozoa.—(?) *Mopsea* sp.<br>Echinodermata.—(?) *Antedon* sp. (arm ossicles); echinoid plates and spines, indet.<br>Vermes.—*Serpula ouyenensis*, Chapm.<br>Polyzoa.—*Cellaria rigida*, vars. *perampla*, Waters, and *venusta*, McG.; *C. contigua*, McG.; *C. angustiloba*, Busk sp.; *Smittia tatei*, T. W. sp.; *Porina gracilis*, M. Edw. sp.; *Bipora philippinensis*, Busk sp.; *Entalophora verticillata*, Goldf. sp.<br>Ostracoda.—*Cythere militaris*, G. S. B. sp. |
| 564–566 .. | Soft calcareous sand-rock | Foraminifera.—*Marginulina costata*, Batsch sp.; *Cristellaria cultrata*, Montf. sp.; *Polymorphina elegantissima*, P. and J.; *P. gibba*, d'Orb.; *Uvigerina angulosa*, Will.; *Pulvinulina elegans*, d'Orb. sp., and var. *partschiana*, d'Orb. var.; *P. repanda*, F. and M. sp.; *Rotalia venusta*, Brady; *R. clathrata*, Brady; *Nonionina umbilicatula*, Mont. sp.; *Polystomella verriculata*, Brady; *Amphistegina lessonii*, d'Orb.; *Operculina complanata*, Defr., and var. *granulosa*, Ley.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Fibularia gregata*, Tate.<br>Vermes.—*Serpula ouyenensis*, Chapm.; *Spirorbis* sp.<br>Polyzoa.—*Cellaria contigua*, McG.; *C. angustiloba*, Busk sp.; *Porina gracilis*, M. Edw. sp.; *Bipora philippinensis*, Busk sp.<br>Ostracoda.—*Cythere postdeclivis*, Chapm. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

### Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 565–570 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster* sp.; *Fibularia gregata*, Tate; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.; echinoid test fragments, indet.<br>Polyzoa.—*Cellepora fossa*, Hasw. sp.; *Retepora*, sp.<br>Brachiopoda.—*Magellania insolita*, Tate. |
| 566–568 .. | Soft calcareous sand-rock | Foraminifera.—*Cassidulina subglobosa*, Brady; *Polymorphina elegantissima*, P. and J.; *Pulvinulina elegans*, d'Orb. sp., and var. *partschiana*, d'Orb. var.; *Rotalia clathrata*, Brady; *Polystomella verriculata*, Brady; *Operculina complanata*, Defr.; *O. venosa*, F. and M. sp.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—Echinoid plates (cidaroid), indet.<br>Vermes.—*Serpula ouyenensis*, Chapm.<br>Polyzoa.—*Cellaria rigida*, var. *perampla*, Waters; *C. angustiloba*, Busk sp.; *C. acutimarginata*, McG.; *Porina gracilis*, M. Edw. sp.; *Bipora philippinensis*, Busk sp.; *Cellepora fossa*, Hasw. sp.; *Smittia tatei*, T. W. sp. |
| 568–570 .. | Hard, calcareous sand-rock | Contains polyzoa (*Cellaria* sp., &c.) and (?) *Serpula* sp. |
| 570 .. | .. .. .. | Chela of crab, indet. |
| 570–575 .. | Washed material .. | Echinodermata.—*Echinocyamus* (*Scutellina*) *patella*, Tate sp.<br>Pelecypoda.—*Pecten flindersi*, Tate; *Spondylus gæderopoides*, McCoy (fragments). |
| 575–580 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster* sp.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.; echinoid plates and spines, indet.<br>Polyzoa.—*Diastopora patina*, Lamx.; *Lichenopora porosa*, McG.<br>Brachiopoda.—*Magellania insolita*, Tate.<br>Pelecypoda.—*Spondylus gæderopoides*, McCoy. |
| 580–585 .. | Washed material .. | Foraminifera.—*Operculina complanata*, Defr.<br>Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—*Pentagonaster* sp.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.; echinoid plates and spines, indet.<br>Polyzoa.—*Porina gracilis*, M. Edw. sp.; *Lichenopora* cf. *porosa*, McG.<br>Brachiopoda.—*Magellania garibaldiana*, Dav. sp.; *Terebratulina catinuliformis*, Tate.<br>Pelecypoda.—*Pecten polymorphoides*, Zittel. |
| 585–590 .. | Washed material .. | Anthozoa.—*Mopsea tenisoni*, Chapm.<br>Echinodermata.—(?) *Pentagonaster*; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.; echinoid test fragments, indet.<br>Vermes.—*Serpula ouyenensis*, Chapm.<br>Polyzoa.—*Cellepora fossa*, Hasw. sp.; *Porina gracilis*, M. Edw. sp.<br>Brachiopoda.—*Terebratulina catinuliformis*, Tate. |

## Details of Bores Nos. 1 to 11, etc.—*continued.*

Bore No. 11—*continued.*

| Depth (feet). | Nature of Rock. | Details and Fossil Contents. |
|---|---|---|
| 590–595 .. | Washed material .. | Echinodermata.—*Pentagonaster* sp.<br>Polyzoa.—*Cellepora* sp.<br>Pelecypoda.—*Spondylus gæderopoides*, McCoy. |
| 595–600 .. | Washed material .. | Foraminifera.—*Polymorphina elegantissima*, P. and J.; *Operculina complanata*, Defr.<br>Echinodermata.—*Pentagonaster* sp.; *Echinocyamus* (*Scutellina*) *patella*, Tate sp.; echinoid plates, indet.<br>Polyzoa.—*Cellaria rigida*, var. *perampla*, Waters; *Porina gracilis*, M. Edw. sp.; *Cellepora fossa*, Hasw. sp.<br>Brachiopoda.—*Magellania insolita*, Tate.<br>Pelecypoda. — *Spondylus gæderopoides*, McCoy; *Pecten foulcheri*, T. W.; *P. præcursor*, Chapm. |
| 600 .. | Fragments of black flint | In this bed boring was stopped. The flint contains numerous remains of polyzoa and foraminifera, and is virtually a silicified polyzoal limestone. |

## Notes on Bore No. 11.

From the surface down to 148 feet the deposits are sandy and pebbly. Near the surface to 28 feet below, the hard, pinkish, concretionary limestone again appears, as in previous bores (No. 7, at 4–8 feet; No. 8, at 3–10 feet, represented by pale marly concretions or "race"; No. 9, at 3–14 feet, and again at 56–69 feet and at 73–90 feet; No. 10, at 20–21 feet, and possibly at several levels down to 87 feet). The repeated occurrences of this concretionary limestone at different levels in the earlier bores points to a periodic accumulation of sub-aerial eroded material, with accompanying subsidence of the land surface, and a recurrence of the dry conditions with salt lagoons suitable for the production of this rock. (See note appended to Bore No. 9.)

From 148–175 feet, Upper Pliocene and Pleistocene estuarine deposits are represented by green sandy clays with brackish water and shallow marine organisms.

The summit of the Kalimnan series is probably touched at 175 feet, and may extend down to 267 feet, where the facies points to a Janjukian origin. From thence to the bottom of the bore the series is distinctly Janjukian (including the Mount Gambier, the Upper Spring Creek, and the Batesford facies).

The peculiarity of the lowest 350 feet of this bore is the great development of the white, chalky, polyzoal rock of the Mount Gambier and Batesford Filter Quarries type, both in a lithological and a faunal sense. This deposit was undoubtedly formed in moderately deep water, as indicated by the numerous reteporids and the deep-water ostracod, *Cythere dictyon*. The condition of the water in which these organisms lived must have been remarkably clear from terrigenous (silty) sediment; for this is shown by the presence of certain foraminiferal and ostracodal types, as well as by the polyzoa, which all afford substantial evidence as to the deepening of the "Murray Gulf" at this spot.

### Note on Black Flint in Base of Bore No. 11 at 600 Feet.

These flint bands are a common feature in certain of the Janjukian (polyzoal) rocks of Victoria and South Australia. Dr. G. J. Hinde, F.R.S., has written an interesting note (Geol. Mag., Dec. III., Vol. VIII., 1891, p. 115) upon a nearly similar rock occurring in the Cainozoics of Yorke Peninsula, South Australia, sent to London by Mr. H. Y. L. Brown, F.G.S. The only difference between the present black flint and the cherty rock referred to appears to be in the yellowish colour of the latter, and in its less glassy and more wavy texture. As in the South Australian specimen, the present sample contains numerous polyzoa, and also foraminifera, but siliceous sponge remains appear to be absent, or they may have been subsequently dissolved during the formation of the chert or flint. There is no doubt that, as in the case of the chalk flint, the Victorian and South Australian Tertiary flints are due to the silicification of the calcareous ooze *in situ*, the primary source of the silica being in all probability the siliceous sponges.

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## 6. LIST OF SPECIES FOUND IN THE MALLEE BORES Nos. 1–11.*

Name.

PLANTÆ.

Boring fungus, indet.
Lithothamnion ramosissimum, Rss. sp.
,, aff. lichenoides, Ell. and Sol.
,, spp. indet.
(?) Lithophyllum sp.

ANIMALIA.

Foraminifera.

Biloculina elongata, d'Orb.
,, irregularis, d'Orb.
Miliolina oblonga, Mont. sp.
,, circularis, Born. sp.
,, trigonula, Lam. sp.
,, seminulum, L. sp.
,, vulgaris, d'Orb. sp.
,, cuvieriana, d'Orb. sp.
,, ferussacii, d'Orb. sp.
,, bicornis, W. and J. sp.
,, schreiberiana, d'Orb. sp.
,, agglutinans, d'Orb. sp.
,, (Massilina) secans, d'Orb. sp.
Trillina howchini, Schlumb.
Sigmoïlina schlumbergeri, A. Silv.
,, sp. indet.
Planispirina sphæra, d'Orb. sp.
,, exigua, Brady
Hauerina intermedia, Howchin
Orbitolites complanata, Lam.
Haplophragmium emaciatum, Brady
,, canariense, d'Orb. sp.
,, sphæroidiniforme, Brady
Ammodiscus ovalis, Chapm.
Textularia gibbosa, d'Orb.
,, sp. indet.
Spiroplecta sagittula, Defr. sp.
,, gramen, d'Orb. sp.
Gaudryina pupoides, d'Orb.
,, rugosa, d'Orb.
Verneuilina spinulosa, Rss.
Bulimina elegans, d'Orb.
,, elegantissima, d'Orb.
,, contraria, Rss. sp.
Virgulina schreibersiana, Cz.
Bolivina punctata, d'Orb.
,, textilarioides, Rss.
,, nobilis, Hantken
,, limbata, Brady
,, robusta, Brady
,, sp. indet.

Name.

Foraminifera—*continued.*

Cassidulina subglobosa, Brady
,, oblonga, Rss.
Lagena gracilis, Will.
,, squamosa, Mont. sp.
,, schlichti, A. Silv.
,, marginata, W. and
,, orbignyana, Seg.
Nodosaria (Glandulina) lævigata, d'Orb.
,, scalaris, Batsch sp.
,, raphanus, L. sp.
,, badenensis, d'Orb.
,, affinis, d'Orb.
,, (Dentalina) pauperata, d'Orb. sp.
,, ( ,, ) consobrina, d'Orb.
,, ( ,, ) soluta, Rss.
,, ( ,, ) multilineata, Born. sp.
,, ( ,, ) obliqua, L. sp.
Frondicularia complanata, Defr.
,, inæqualis, Costa
,, lorifera, Chapman
Marginulina glabra, d'Orb.
,, costata, Batsch sp.
Vaginulina legumen, L. sp.
Cristellaria tricarinella, Rss.
,, aculeata, d'Orb.
,, articulata, Rss
,, rotulata, Lam. sp.
,, cultrata, Montf. sp.
Polymorphina lactea, W. and J. sp.
,, gibba. d'Orb.
,, compressa, d'Orb.
,, elegantissima, P. and J.
,, dispar, Stache
,, communis, d'Orb.
,, problema, d'Orb.
,, oblonga, d'Orb.
,, regina, B. P. and J.
,, sororia, Rss.
,, rotundata, Born. sp.
Uvigerina angulosa, Will.
,, tenuistriata, Rss.
Sagraina striata, Schwager
,, raphanus, P. and J.
Globigerina bulloides, d'Orb.
,, triloba, Rss.
,, conglobata, Brady
,, sp. indet.
Pullenia quinqueloba, Rss.
Sphæroidina bulloides, d'Orb.
Patellina corrugata, Will.

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* For details see "Descriptions of New and Rare Fossils obtained by Deep Boring in the Mallee"; Pt. I., Plantæ; and Rhizopoda to Brachiopoda (F. Chapman), Proc. Roy. Soc. Vict., Vol. XXVI. (n.s.), Pt. I., 1913; Pt. II., Mollusca (F. Chapman and C. J. Gabriel), *Ibid.* Vol. XXVI. (n.s.), Pt. 2, 1914; Pt. III., Ostracoda to Fishes (F. Chapman), *Ibid.*, Vol. XXVII. (n.s.), Pt. I., 1914.

## A List of Species found in the Mallee Bores Nos. 1–11—*continued.*

Name.

### Foraminifera—*continued.*

Discorbina araucana, d'Orb. sp.
,, bertheloti, d'Orb. sp.
,, parisiensis, d'Orb. sp.
,, dimidiata, P and J.
,, globularis, d'Orb. sp.
,, turbo, d'Orb. sp.
,, pileolus, d'Orb. sp.
,, obtusa, d'Orb. sp.
,, biconcava, P. and J.
Planorbulina larvata, P. and J.
Truncatulina lobatula, W. and J. sp.
,, variabilis, d'Orb.
,, refulgens, Montf. sp.
,, wuellerstorfi, Schw. sp.
,, ungeriana, d'Orb. sp.
,, akneriana, d'Orb.
,, reticulata, Cz. sp.
,, tenera, Brady
,, haidingeri, d'Orb. sp.
,, sp. indet.
Anomalina ammonoides, Rss. sp.
,, polymorpha, Costa
Carpenteria proteiformis, Goës
Pulvinulina elegans, d'Orb. sp.
,, ,, var. partschiana, d'Orb. var.
,, repanda, F. and M. sp.
,, ,, var. concamerata, Mont. var.
,, calabra, Costa sp.
,, auricula, F. and M. sp.
,, exigua, Brady
,, karsteni, Rss. sp.
,, scabricula, Chapm.
,, truncatulinoides, d'Orb. sp.
,, schreibersii, d'Orb. sp.
Rotalia beccarii, L. sp.
,, papillosa, Brady
,, ,, var. compressiuscula, Brady
,, clathrata, Brady
,, calcar, d'Orb. sp.
,, orbicularis, d'Orb. sp.
,, soldanii, d'Orb.
,, venusta, Brady
Gypsina howchini, Chapman
, vesicularis, P. and J.
,, globulus, Rss. sp.
Nonionina depressula, W. and J. sp.
,, umbilicatula, Mont. sp.
,, boueana, d'Orb.
,, scapha, F. and M. sp.
Polystomella striatopunctata, F. and M. sp.
,, ,, var. evoluta, Chapman
,, macella, F. and M. sp.
,, crispa, L. sp.
,, subnodosa, Münst. sp.
,, imperatrix, Brady
,, verriculata, Brady
,, craticulata, F. and M. sp.
Amphistegina lessonii, d'Orb.
,, sp. indet.
Operculina complanata, Defr.
,, ,, var. granulosa, Ley.
,, venosa, F. and M. sp.

### Spongiæ.

Triradiate spicules of calcisponges, indet.
Sponge spicules, indet.

### Anthozoa.

Holcotrochus crenulatus, Dennant
Placotrochus elongatus, Duncan
,, deltoideus, Duncan
Sphenotrochus emarciatus, Duncan
Deltocyathus fontinalis, Dennant
Bathyactis lens, Duncan sp.
,, beaumariensis, Dennant
Notophyllia variolaris, Dennant
Graphularia senescens, Tate sp.
Mopsea tenisoni, Chapman
,, hamiltoni, Thomson sp.
Isis compressa, Duncan

Name.

### Echinoderma.

Antedon protomacronema, Chapm.
,, sp. (brachials)
,, sp. (cirrus joint)
Pentagonaster sp.
Cidaris sp.
Goniocidaris sp.
Paradoxechinus novus, Laube
Psammechinus woodsi, Laube sp.
Echinocyamus (Scutellina) patella, Tate sp.
Fibularia gregata, Tate
Clypeaster gippslandicus, McCoy
Arachnoides (Monostychia) australis, Laube sp.
Echinoneus dennanti, Hall
Linthia sp.
cf. Eupatagus sp.
Lovenia forbesi, T. Woods sp.
Echinoid test fragments and spines, indet.

### Annelida.

Serpula ouycnensis, Chapman
Ditrupa cornea, L. sp., var. wormbetiensis, McCoy
,, cornea, var. constricta, Chapman
Spirorbis heliciformis, Eichwald

### Polyzoa.

#### Cyclostomata.

Idmonea hochstetteriana, Stol. sp.
,, lata, MacGill.
,, sp.
Hornera diffusa, MacGill.
,, frondiculata, Lamx.
,, sp.
Diastopora patina, Lamx.
Entalophora, nr. sparsa, Mapl.
,, verticillata, Goldf. sp.
,, sp.
Lichenopora australis, MacGill.
,, porosa, MacGill.
,, radiata, Audrouin sp.
,, wilsoni, MacGill. sp.
Heteropora pisiformis, MacGill.

#### Cheilostomata.

Catenicella sp.
Claviporella sp.
Caberea grandis, Hincks
Cellaria acutimarginata, MacGill. sp.
,, angustiloba, Busk sp.
,, australis, MacGill.
,, contigua, MacGill.
,, rigida, MacGill.
,, ,, var. perampla, Waters
,, ,, var. venusta, MacGill.
Membranipora cf. fossa, MacGill.
Lunulites canaliculata, MacGill.
,, (?) parvicella, T. W. sp.
Selenaria concinna, T. Woods
,, cupola, T. W. sp.
,, marginata, T. W.
,, ,, var. lucens, MacGill.
,, ,, var. pulchella, MacGill.
,, ,, var. spiralis, Chapm.
Steganoporella magnilabris, Busk sp.
,, patula, Waters sp.
Macropora clarkei, T. W. sp.
Microporella magna, T. W. sp.
Tessaradoma elevata, Waters sp.
,, magnirostris, MacGill.
Adeona sp. (anchoring roots)
Lepralia burlingtoniensis, Waters
,, corrugata, MacGill.
,, crassatina, Waters sp.
,, elongata, MacGill.
,, gippslandii, Waters
,, (?) graysoni, Maplestone
Schizoporella (?) convexa, MacGill.
(?) Schizoporella sp.
Bipora cancellata, Busk sp.
,, philippinensis, Busk sp.
Smittia tatei, T. W. sp.
Porina gracilis, M. Edw. sp.
(?) Lekythopora sp.

## A List of Species found in the Mallee Bores Nos. 1–11—*continued.*

Name.

### Polyzoa—*continued.*

#### Cheilostomata—*continued.*

Cellepora fossa, Hasw. sp.
„ gambierensis, T. W.
„ tridenticulata, Busk
„ „ var. nummularia, Busk
„ sp. (a massive form)
(?) Schismopora costazei, Aud. sp.
Schismopora incus, MacGill.
Retepora producta, Busk
„ sp.

### Brachiopoda.

Terebratulina catinuliformis, Tate
„ flindersi, Chapm.
„ triangularis, Tate
Terebratula tateana, T. Woods
Terebratella acutirostra, Chapm.
„ portlandica, Chapm.
Magasella compta, Sow. sp.
„ lunata, Tate
„ woodsiana, Tate
Magellania garibaldiana, Dav. sp.
„ insolita, Tate

### Pelecypoda.

Nucula morundiana, Tate
„ obliqua, Lamarck
„ semistriata, Tate
Leda acinaciformis, Tate
„ apiculata, Tate
„ crassa, Hinds
„ huttoni, T. Woods
„ woodsi, Tate
Cucullæa corioensis, McCoy
Limopsis beaumariensis, Chapman
„ „ var. depressa, Ch.
„ insolita, G. Sow. sp.
Arca (Fossularca) dissimilis, Tate sp.
Lissarca rubricata, Tate sp.
Glycimeris cainozoicus, T. Woods sp.
„ convexus, Tate sp.
„ halli, Pritchard
„ „ var. intermedia, Pr.
„ „ var. paucicostata, Pr.
„ maccoyi, Johnston sp.
Perna percrassa, Tate sp.
Pteria (Margaritifera) crassicardia, Tate sp.
Ostrea hyotidoidea, Tate
„ manubriata, Tate
Gryphæa tarda, Hutton
Trigonia howitti, McCoy
„ lamarcki, Gray
„ margaritacea, Lam., var. acuticostata, McCoy
Pecten antiaustralis, Tate
„ eyrei, Tate
„ flindersi, Tate
„ foulcheri, T. Woods
„ gambierensis, T. Woods
„ murrayanus, Tate
„ peroni, Tate
„ polymorphoides, Zittel
„ præcursor, Chapm.
„ sturtianus, Tate
Amussium zitelli, Hutton
Spondylus, gæderopoides, McCoy
Dimya dissimilis, Tate
Lima (Limatula) jeffreysiana, Tate
Placunanomia ione, Gray
Mytilus deperditus, Tate
Arcoperna scapha, Verco
Crassatellites communis, Tate sp.
„ kingicoloides, Pr.
Cuna concentrica, Hedley
„ polita, Tate sp.
„ radiata, Tate sp.
Condylocardia tenuicostæ, Chapm. and Gabr.
Cardita calva, Tate
„ compacta, Tate
„ latissima, Tate
„ pecten, Tate
„ solida, Tate
„ spinulosa, Tate

Name.

### Pelecypoda—*continued.*

Rochefortia donaciformis, Angas sp.
Erycina micans, Tate sp.
Montacuta sericea, Tate
Dosinia grayi, Zittel
Venus (Chione) hormophora, Tate sp.
„ ( „ ) propinqua, T. W. sp.
„ ( „ ) subroborata, Tate sp.
Meretrix murrayana, Tate sp.
Psammobia æqualis, Tate
Donax kenyoniana, Chapm. and Gabr.
Mactra axiniformis, Tate
„ hamiltonensis, Tate
„ howchiniana, Tate
Corbula coxi, Pilsbry
„ ephamilla, Tate
„ pyxidata, Tate
Barnea tiara, Tate

### Scaphopoda.

Dentalium aratum, Tate
„ australe, Sharp and Pilsbry
„ latesulcatum, Tate
„ mantelli, Zittel
Cadulus acuminatus, Tate

### Polyplacophora.

Spp. indet.

### Gasteropoda.

Liopyrga quadricingulata, Tate
„ sayceana, Tate
Liotia dennanti, Chapm. and Gabr.
Euchelus tasmanicus, T. Woods
Clanculus aff. aloysii, T. Woods
Teinostoma depressula, Chapm. and Gabr.
„ pulcherrima, Chapm. and Gabr.
Cyclostrema homalon, Verco
„ harriettæ, Petterd
Eulima pinguicula, Chapm. and Gabr.
Niso psila, T. Woods
Pyramidella jonesiana, Tate sp.
Turbonilla weeahensis, Chapm. and Gabr.
Eglisia triplicata, T. Woods sp.
Calyptræa corrugata, Tate
„ kalimnæ, Chapm. and Gabr.
Natica cunninghamensis, Harris
„ hamiltonensis, Tate
„ perspectiva, Tate
„ subinfundibulum, Tate
„ „ var. crassa, Tate
„ substolida, Tate
„ subvarians, Tate
„ wintlei, T. Woods
Rissoa gatliffeana, Chapm. and Gabr.
„ varicifera, T. Woods
„ (Onoba) bassiana, Hedley
„ „ chrysalida, Chapm. and Gabr.
Turritella circumligata, Verco
„ murrayana, Tate
„ pagodula, Tate
„ platyspira, T. Woods
„ tristira, Tate
Cerithium apheles, T. Woods
„ torrii, Tate
Tylospira coronata, Tate sp.
Cassis contusa, Tate
„ (Semicassis) subgranosa, Tate sp.
Lotorium tortirostre, Tate sp.
„ tumulosum, Tate sp.
Nassa spiraliscabra, Chapm. and Gabr.
Zemira præcursoria, Tate
Tudicla costata, Tate
„ turbinata, Tate
Fasciolaria rugata, Tate sp.
Marginella hordeacea, Tate
„ muscarioides, Tate
„ præformicula, Chapm. and Gabr.
„ wentworthi, T. Woods
Voluta, weldi, T. Woods
Ancilla hebera, Hutton sp.
„ papillata, Tate sp.

## A List of Species found in the Mallee Bores Nos. 1–11—*continued*.

Name.

Gasteropoda—*continued.*

Terebra angulosa, Tate
,, geniculata, Tate
,, profunda, Chapm. and Gabr.
,, simplex, T. Woods
,, subspectabilis, Tate
Pleurotoma selwyni, Pritchard
,, trilirata, Harris
,, (Drillia) dilectoides, Chapm. and Gabr.
,, ( ,, ) trevori, T. Woods sp.
Bela sculptilis, Tate
Tornatina aptycha, Cossman
Volvulella inflatior, Cossman
Bullinella aratula, Cossman
Vaginella cf. eligmostoma, Tate

Ostracoda.

Argilloecia badia, G. S. Brady
Macrocypris decora, G. S. B. sp.
,, tumida, G. S. B.
Bythocypris tumefacta, Chapm.
Bairdia amygdaloides, G. S. B.
,, australis, Chapm.
Cythere canaliculata, Reuss sp.
,, crispata, G. S. B.
,, dasyderma, G. S. B.
,, demissa, G. S. B.
,, dictyon, G. S. B.
,, flexicostata, Chapm.
,, lactea, G. S. B.
,, lepralioides, G. S. B.
,, lubbockiana, G. S. B.
,, militaris, G. S. B. sp.
,, normani, G. S. B.
,, obtusalata, G. S. B.
,, ovalis, G. S. B.
,, parallelogramma, G. S. B.
,, postdeclivis, Chapm.
,, rastromarginata, G. S. B.
,, scabrocuneata, G. S. B.
,, scintillulata, G. S. B.
,, scutigera, G. S. B.
,, wyville-thomsoni, G. S. B.
Krithe eggeri, Chapm.

Name.

Ostracoda—*continued.*

Loxoconcha australis, G. S. B.
Xestoleberis curta, G. S. B. sp.
,, margaritea, G. S. B.
,, variegata, G. S. B.
Cytherura capillifera, G. S. B.
,, ouyenensis, Chapm.
Cytheropteron batesfordiense, Chapman
,, ,, var. aculeata, Chapm.
,, postumbonatum, Chapm.
,, præantarcticum, Chapm.
,, reticosum, Chapm.
,, rostratum, Chapm.
Cytherella auriculus, Chapm.
,, lata, G. S. B.
,, polita, G. S. B.
,, pulchra, G. S. B.
,, punctata, G. S. B.
,, subtruncata, Chapm.

Cirripedia.

Scalpellum subquadratum, Chapm.
Balanus psittacus, Molina sp.
,, varians, Sow.

Decapoda.

Chelæ of Crustacea, indet.

Pisces.

Cestracion cainozoicus, Chapm. and Pritch.
Galeocerdo aduncus, Agassiz
Lamna compressa, Agassiz
Carcharodon auriculatus, Blainville sp.
Trygon cf. rugosus, Probst sp.
Myliobatis moorabbinensis, Chap. and Pr.
Chimæroid teeth, indet.
(?) Chrysophrys sp.
Diodon formosus, Ch. and Pr.
Teleostean fish otoliths

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## 7. THE SEQUENCE AND CLASSIFICATION OF THE CAINOZOIC OF THIS AREA.

The Tertiary strata of southern Australia of the same time equivalents comprise an extremely variable lithological series in different localities. This variability has occasioned a great deal of confusion regarding the exact stratigraphical succession of the Tertiary beds as exposed in limited cliff sections and excavations. A series of deep borings like the present is therefore extremely valuable, not only to the geologist, but also to the hydraulic engineer, since, while settling the question of the true vertical succession of the beds, it furnishes data for correctly estimating the position and extent of the underlying water-bearing strata.

Drawing upon the data previously given in detail, we find the basal beds of the last boring, from 267 feet down to 600 feet, consisting of a white polyzoal limestone, with occasional chert, and similar to that of the Mount Gambier series both in structure and organic contents. The polyzoa point to a close relationship in age, many of the species being identical with those of the Mount Gambier fauna. Amongst the microzoa there occur several species of foraminifera hitherto restricted to the Batesford beds, and the ostracoda also show many points in common with species from the same strata. There is, further, a strong Aldingan aspect in the fauna which helps to confirm this view as to the Janjukian age of the beds.

The easterly bores of the Kow Plains series show a marked thickening of the polyzoal limestones, whilst to the westward these beds become thinner and more sandy, ultimately passing into green sands, with a stronger Aldingan facies.[1]

The natural inference from these data is that the western deposits at the same geological horizon were formed under current action. They are purely terrigenous in character, with a rich fish fauna. The eastward series was formed in deeper water, or where the conditions were conspicuously tranquil and free from irruptions of sediment such as terrigenous sands and muds. The consequence of this is that they show a predominant polyzoal fauna. The almost entire absence of corals may be accounted for by the presence of so much excessively fine calcareous sand formed mainly of foraminiferal shells, which would obviously tend to deter coral growth. In the one case the sediments were gathered by current action ; in the other they consist of material which lived and died on the spot, the finer muds, when not foraminiferal, being formed of powdered polyzoa ground by the agency of the wrasses and other fishes with strong mandibular teeth, evidence of such fishes being shown in the fossil lists appended.

Making allowance for the boring tube penetrating two or more distinct groups at one run, the sequence of the strata is clearly proved in this set of bores. The next in ascending order is the series of beds of Kalimnan age, into which the Janjukian strata pass almost insensibly. These Kalimnan beds consist of shelly marls and sands containing a predominant bivalve fauna, and are more generally of a littoral facies.

To the Upper Pliocene (Werrikooian) beds may be referred the estuarine sands containing undersized specimens of foraminifera of estuarine types, which are characteristically thin-shelled and therefore easily floated into shore-pools, as they are at the present day. In illustration of this, the bore tube has sometimes penetrated a deposit of an almost pure gathering of these shells. Estuarine and shallow water ostracoda are also of frequent occurrence, as well as the minute spines of spatangoid sea-urchins.

The fossiliferous sands and silts are overlain by barren quartz sands and grits, sometimes replaced by a thick deposit of micaceous grey, angular sand. These beds are referred to the Pleistocene.

Later Pleistocene and Holocene.—These stages are represented, firstly, by white, yellow and red sands, the two latter being ferruginous-coated quartz sands ; and secondly, by earth-coated sands with fibrous vegetable remains, at or near the surface. At several horizons we meet with thin to thick deposits of pinkish concretionary limestone, which in some instances have afforded evidence of the co-existence of land-shells, such as live in saline lakes at the present day.[2]

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[1] In connexion with the two different aspects of the Janjukian sedimentation in the Mallee bores it may not be out of place to quote Prof. R. Tate's remarks regarding the South Australian distribution and relationship of the Mount Gambier polyzoal limestone and the Aldinga marls. (see Trans. Roy. Soc. S. Aust. Vol. XX., 1896, p. 115) :—

"The Eocene beds of the Mount Gambier district are entirely isolated from all the other Eocene deposits, not only by their position, far removed from all other places where outcrops occur, but also by their fauna, which, with the exception of polyzoa, is extremely limited, consisting of about sixteen molluscs and six echinoderms, many of which are widespread forms." [No reference is made to the rich ostracodal and foraminiferal fauna.] "However, by the wells at Bordertown and Pinaroo, we see the probable continuity of the Mount Gambier beds with those at Overland corner, while the four bores in the Ninety-mile Desert show that the same beds, at lower depth, join on to the Murray beds at Tailem Bend, and thus it is safe to say that the Murravian and Mount Gambier Eocenes are portions of the same deposit.

"Then also the similarity of the fauna of the sands met with in the Ki Ki bore with that of the Aldinga marls, would show that these two beds were deposited at the same time, from which we might infer that the polyzoal limestone which overlies the marls at Aldinga is contemporaneous with the similarly composed beds resting on the sands and clays, as shown in the accompanying diagram, and therefore with the Mount Gambier and Murravian deposits. Still, we see from the four bores above described that the line of separation of the sands and clays from the overlying polyzoal rock is very irregular, which tends to prove that, although on the whole the sands are the older of the two beds, nevertheless they were being deposited at the same time in localities very near together, and that therefore local causes had a good deal to do in determining their deposition ; so that, considering how far removed are Aldinga and the Murray Cliffs, we might be making a mistake in saying that the Aldinga marls are older than the Murravian limestone, though this is probably the case ; and at any rate we may be fairly safe in concluding that no period of any length separated their formation."

[2] See note at end of table, Bore No. 9, p. 353.

The following table will help to make the sequence of the beds represented in the Mallee bores more clearly understood :—

| Deposits. | Maximum Thickness in Feet. | Stage. |
|---|---|---|
| Brown, fibrous, sandy loam, sometimes underlain by pink lacustrine limestone, also steatitic clays, white and ferruginous sands, sometimes with a dull polish, and angular to sub-angular grains | 148 | Holocene and Pleistocene |
| Estuarine sands with brackish water and marine shells | 163 | Newer Pliocene (Werrikooian) |
| Green sands and shell-marls with *Glycimeris convexus* and *Limopsis beaumariensis* | 92 | Older Pliocene (Kalimnan) |
| Green sands, white marls, cherts, polyzoal rock, with fish-remains and abundance of *Fibularia gregata*, *Echinocyamus* (*Scutellina*) *patella*, and *Terebratulina catinuliformis* | 333 | Miocene (Janjukian with a Gambierian[1] facies) |

## 8. EVIDENCE OF CLIMATIC ZONES.

### The Janjukian Climate.

The oldest of the Tertiary beds of the "Murray Gulf" area belongs to the Janjukian series of Hall and Pritchard. The typical Spring Creek fauna, upon which the above term was based, comprises, at Torquay, both the molluscan facies below and the polyzoal facies above. In the "Murray Gulf" the conditions giving rise to these two sets of beds seem to have been reversed, for we find the polyzoal limestone in the deeper parts of the bores, and the glauconite sands and shell marls above, passing insensibly into the Kalimnan beds.

The life forms of this series were very numerous, and the fauna must be one of the richest assemblages known. This is borne out by the record of species in the present report. So far as I have been able to ascertain, up to the present more than 1,244 species of marine fossils have been described from this formation; and with careful research, especially amongst the smaller forms, this number could be largely augmented. The numbers of the forms in each group are as follows :—

| | | | |
|---|---|---|---|
| Plants .. .. | 4 | Pelecypoda .. | 178 |
| Foraminifera .. .. | 167 | Gasteropoda .. | 348 |
| Sponges .. .. | 3 | Ostracoda .. .. | 43 |
| Corals .. .. | 39 | Cirripedes .. .. | 4 |
| Echinoids .. .. | 22 | Crustacea .. .. | 1 |
| Worms .. .. | 4 | Fishes .. .. | 27 |
| Polyzoa .. .. | 365 | Mammalia .. .. | 7 |
| Brachiopoda .. .. | 32 | | |

These faunal totals are computed from the fossil lists of Victoria, South Australia and Tasmania.

These facts are in accordance with what is known of the rich Miocene faunas elsewhere, and can be partially explained from two stand-points: first, the genial climatic conditions; second, the great variety of the conditions of the shore-line consequent upon extensive diastrophic movements of the earth's crust and general prevalence of subsidence along coastal areas.

Several hitherto supposed extinct forms of mollusca from this and the next older and younger stages have been lately discovered by Mr. Hedley

[1] Typically represented by the white polyzoal limestone of Mount Gambier, South Australia.

in lower latitudes than their fossil habitats, living along the Australian coast; such are *Trivia avellanoides* and *Trigonia margaritacea*, var. *acuticostata*. Although many of the genera and even of the species of the Janjukian fauna are still living, the general facies is that of a much warmer climate than at present found in southern Australia. There is abundant proof of this in the fact that many of the Janjukian types of mollusca must now be looked for in the Queensland coast fauna and still farther northward.

The abundance of the large volutes, as well as the occurrence of the genera *Harpa*, *Phos*, *Ancilla*, *Pyrula* and *Cucullæa*, with many others, are strongly indicative of warmer coast lines, some being peculiarly Indo-Pacific generic types. Specifically, many of the fossils are closely related to Miocene forms found in the Vienna basin, in the deposits of which the shells clearly indicate a warm temperate to sub-tropical conditions. With regard to this latter point, the peculiar variety of *Amphistegina lessonii*, with a thin periphery and prominent umbilical bosses, formerly known as *A. hauerii*, is the abundant form both in our Janjukian series and the Vienna Tertiaries.

The ostracoda of the Janjukian from the Batesford limestone area have lately received some attention from myself,[1] and the present results are now combined with them, and furnish very interesting data. Thus, a considerable number of the fossil species are living, and can now be found, like some of the foraminifera presently to be mentioned, only to the north of the 35th parallel.

The large discoidal *Orbitolites complanata*, which, by the way, was common in the warm Tertiary seas of the Paris basin, was abundant when the Janjukian green-sands of the Mallee were laid down, but it has now retreated to lower latitudes, being found in Sharks' Bay, Western Australia, at latitude 26°, and off the Great Barrier Reef, Queensland, at about the same parallel. It should be stated, however, that *Orbitolites* was a common genus in South Australian waters in Upper Pliocene times[2] where, in the limited area of the Adelaide Plains basin, it appeared to survive in a "biological backwater," to quote a significant phrase of Professor Gregory.

The lepidocycline foraminifera peculiar to the Balcombian and Janjukian stages have now become extinct, but their trend of habitat was along the tropical and warm temperate coast-line of the old Tethys or Mediterranean Sea from Australia to India and Southern Europe, and even as far as the Antillean region of the West Indies.

The Rev. W. Howchin, F.G.S., has already[3] estimated the climatal range of the Muddy Creek foraminifera of the lower bed, which is a stage older than the oldest beds of the "Murray Gulf," and which I regard as of Oligocene age. Mr. Howchin finds 26 per cent. tropical forms of foraminifera, 47 per cent. warm temperate and tropical, 6 per cent. temperate, and 34 per cent. cosmopolitan. The Janjukian fauna I would regard as showing quite as high, if not higher, thermal conditions, as proved by the prevalence of foraminifera of a distinct coral-sea type.

## The Kalimnan Climate.

The climate at this period must have cooled down considerably after Janjukian times, since the molluscan shells indicate fairly low temperatures, probably varying from warm temperate to cold conditions, the latter characteristic being seen in the presence of *Saxicava* and the abundance of *Tellina* and *Natica*.

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[1] "A Study of the Batesford Limestone." Proc. Roy. Soc. Vict., Vol. XXII. (N.S.), Pt. II., 1910, pp. 298–301, pl. LII.

[2] See Prof. T. W. E. David. Presidential Address, Rep. Aust. Ass. Adv. Sci., Melbourne Meeting, 1918, p. LXXX., footnote 1.

[3] Trans. Roy. Soc. S. Aust., Vol. XII., 1889, p. 18.

By his estimation of climate, from the foraminiferal evidence, Mr. **Howchin** finds[1] that the Kalimnan of Muddy Creek affords 18 per cent. of tropical species of foraminifera, 35 per cent. warm temperate and tropical, 3 per cent. temperate, and 43 per cent. cosmopolitan. This estimation does not include the factor of relative abundance of specimens, but only of the number of species. From the data afforded by the common forms of Kalimnan foraminifera enumerated by Howchin in his "Census,"[2] I arrive at the conclusion that, with the exception of *Orbitolites*, they are all especially characteristic as temperate to cold water species, of shallow-water habitat.

### The Post-Kalimnan Climate.

The next series in ascending order are the Post-Kalimnan estuarine beds with shallow water and brackish foraminifera of a facies exactly like that of the estuarine foraminiferal clays of the north of Ireland,[3] and the deep-seated silts, 15–109 feet below the bed of the Buffalo River in South Africa.[4] The deep-seated estuarine beds of the Mallee may for the present be referred tentatively to the Werrikooian stage of Hall and Pritchard (=Limestone Creek beds, Glenelg River), and probably are on the Upper Pliocene horizon. The microzoa in these deposits point to temperate and cold conditions, the temperate and shallow-water foraminifera, *Rotalia beccarii*, being especially abundant in some of the bores.

The succeeding deposits, here referred to Pleistocene, are devoid of fossil remains.

The rainfall was then probably greater than at present, as shown by the vast sheets of ferruginous and sub-angular sands which were laid down at this time, covering what is termed by Prof. Tate the Murray Plateau.[5] That arenaceous deposit may also be partly accounted for on Professor Tate's assumption that the Murray waters were impounded and spread over a larger area than at present during flood season.[6]

The Holocene deposits are sandy and calcareous, the latter affording evidence of a saline lacustrine fauna in places, in all probability similar to that existing at the present time, with the surface area becoming more and more desiccated.

## 9. NOTES ON THE FAUNAS.

### Fauna of the Janjukian Series.

The oldest of the Cainozoic series touched by the present borings is, as already stated, of Janjukian age. In the earlier bores, situated to the west of the line of borings, the samples of this age, which are comparable with the Spring Creek or Torquay series, are generally of a glauconitic nature, although there is, in the deeper parts, a trace of the white polyzoal rock of the eastern bores. This glauconitic marl is very like that found in the top of the dome-shaped anticline at the foot of Bird Rock, Torquay, and represents fairly

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[1] Trans. Roy. Soc. S. Aust., Vol. XII., 1889, p. 19.
[2] Aust. Ass. Adv. Sci. Adelaide, 1893, pp. 352–4.
[3] J. Wright. Proc. Belfast Nat. Field Club. Appendix, 1879–80, p. 149–163.
[4] F. Chapman. Rec. Albany Mus., Vol. II., No. 1, 1907, pp. 6–17.
[5] Trans. Roy. Soc. S. Aust., Vol. VII., 1885, p. 25.
[6] *Loc. cit.*, pp. 31, 32.

deep water conditions, under which there probably ensued a large amount of disturbance by submarine currents. It is generally under such conditions that the richest fish faunas flourish, and such seems to have been the case in this Janjukian gulf at the place where the glauconitic marls were laid down. It is usual in these green-sand samples also, to find the group of the ostracoda thoroughly representative and abundant. Deep-water species of the ostracoda are typical in these green sands, as *Cythere dictyon*, which also occurs frequently in the white limestone or polyzoal rock of the later bores associated with other deep-water species as *Cythere dasyderma*, *C. normani* and *C. scutigera*. Having a distinctly glauconitic deposit we may reasonably conclude that it was formed at greater depths than the ordinary mud-line of 100 fathoms. The large proportion of nodosarines amongst the foraminifera occurring in the green-sands would also point to their deep-water habitat. As a rule the polyzoal rock underlies the green-sand and marl in the old Murray Gulf, as revealed by the borings. At Torquay, conversely, this limestone forms the younger part of the series, overlying the blue and green glauconitic clays of the basal beds of Bird Rock. It is thereby seen that these two phases of sedimentation have sometimes been interchangeable in the Janjukian period according to local conditions; the green-sands representing slow accumulations of living organisms, with much solution and intermittent accessions of terrigenous material to the deposits, whilst the polyzoal phase shows a clarity of water and an evenly subsiding sea-bed. The deeper parts of the borings, occurring as they do in polyzoal rock, show a sedimentation of fairly deep-water origin, probably of 100 to 300 fathoms or even more.

The mollusca of the deepest parts of the Mallee bore No. 11 are mainly represented by the genera *Pecten* and *Spondylus;* the brachiopods by *Terebratulina*, *Magellania* and *Magasella;* and the corals by *Bathyactis* and some Alcyonarians. A deposit having a similar fauna was met with in the Gulf of Lyons at about 265 fathoms. The trawler *Endeavour* has lately dredged up some similar material from the Southern Ocean, 40 miles south of Cape Wiles, South Australia, at 100 fathoms. In appearance this dredging was extremely like the fine white polyzoal limestone of the deeper part of the Mallee bores, excepting for its pale-yellowish colour, due to the presence of organic matter. There was practically no clayey material to wash away in order to facilitate the examination of its organic contents, and only a fine residue of 0·4 per cent. of sharp white quartz sand. The bulk of the material consisted of polyzoa and foraminifera, whilst ostracods were fairly common, and alcyonarian joints also present. Of the ostracods in this Southern Ocean deposit the following ten species were common to this and the Mallee fossil deposits of the Janjukian (Miocene) :—

*Macrocypris decora*, G. S. Brady sp.
*Bairdia amygdaloides*, G. S. B.
*Cythere canaliculata*, Reuss. sp.
„ *crispata*, G. S. B.
„ *dictyon*, G. S. B.
„ *lepralioides*, G. S. B.
„ *parallelogramma*, G. S. B.
„ *scabrocuneata*, G. S. B.
*Loxoconcha australis*, G. S. B.
*Xestoleberis variegata*, G. S. B.

The Janjukian series, as revealed in the borings, is sometimes followed by a mixture of Janjukian and Kalimnan faunas, at others immediately by the Kalimnan. Some of the bores have not penetrated beyond the Kalimnan, as bore 7.

The noteworthy species of the Janjukian of the borings may be summarized as follows[1] :—

| | |
|---|---|
| *Lithothamnion ramosissimum*, Reuss sp. | An important calcareous alga in the Miocene in Europe, and characteristic of the polyzoal rock of the present series. |
| *Trillina howchini*, Schlumberger | Previously known from the Balcombian (probably near the top of the beds), at Muddy Creek, as well as in the Miocene of the New Hebrides, in which it was found by the writer associated with typical Miocene *Lepidocyclinæ* in limestone collected by Sir Douglas Mawson. |
| *Orbitolites complanata*, Lamarck | This foraminifer was found living off South Australia till within Pleistocene times. It is now found in lower latitudes. The form also occurs in the Kalimnan of this series. |
| *Frondicularia lorifera*, Chapm. | This species occurs in Janjukian, and, doubtfully, in Kalimnan samples. A striking species. |
| *Carpenteria proteiformis*, Goës | A Balcombian and Janjukian form in Australia. It is here restricted to the Janjukian series. |
| *Pulvinulina scabricula*, Chapm. | Restricted to the Janjukian. Also found at Batesford. |
| *P. calabra*, Costa sp. .. | First described from the Italian Tertiaries; it has since been recorded from the Tertiary marl of Whaingaroa Harbor, New Zealand, named *Rosalina thiara*, by Stache. This occurs in a mixed sample from the borings, which has a preponderance of Janjukian fossils. |
| *Gypsina howchini*, Chapm. .. | A restricted Janjukian fossil, known previously only from Batesford. |
| *Operculina venosa*, Fichtel and Moll sp. | This interesting form is restricted to the Janjukian of the bores. At the present day it is confined to the Great Barrier Reef, Queensland, and the East Indian Archipelago. |

[1] For descriptions of the new and rare fossils from the Mallee borings see Proc. Roy. Soc. Vict., Vol. XXVI. (N.S.), Pt. I., 1913, pp. 165–191, pls. XVI.–XIX. *Ibid.*, Vol. XXVI. (N.S.), Pt. II., 1914 (in conjunction with C. J. Gabriel), pp. 301–330, pls. XXIV.–XXVIII. *Ibid.*, Vol. XXVII., Pt. I., 1914, pp. 28–71, pls. VI.–X.

| | |
|---|---|
| *Deltocyathus fontinalis*, Dennant | This distinct little coral, originally described from the typical Janjukian locality of Torquay, occurs here in true Janjukian beds, as well as in those with an admixture of fossils from the overlying series. |
| *Mopsea tenisoni*, Chapm. .. | The calcareous internodes of this alcyonarian are abundant in the Janjukian of the bores, especially in the white polyzoal limestone. |
| *M. hamiltoni*, Thomson .. | This species is not so common as the preceding, and is practically restricted to the Janjukian. Similar forms are known from the Gaj beds of India (Burdigalian) on about the same geological horizon as the Victorian. It also occurs in the Janjukian of King Island, Bass Strait, and in the Tertiary green-sands of Kakanui, New Zealand. |
| *Isis compressa*, Duncan .. | This alcyonarian, like the last-named, has previously occurred in the Gaj beds of India. It is here restricted to the similar bed of Janjukian age. |
| *Antedon protomacronema*, Chapm. | The present species of *Antedon* or Feather-Star is closely allied to a living species found by the "*Challenger*" in Port Jackson and Port Stephens, New South Wales, and in King George's Sound, Western Australia. |
| *Echinocyamus (Scutellina) patella*, Tate sp. | This is a common little echinoid found universally in the Janjukian of the bores, and practically confined to that series. |
| *Echinoneus dennanti*, Hall .. | This rare form, occurring here in the Janjukian, has only been previously recorded from Batesford. |
| *Serpula ouyenensis*, Chapm. | Practically restricted to the Janjukian of the bores. |
| *Ditrupa cornea*, L., var. *wormbetiensis*, McCoy | In the Victoria Cainozoics this variety of a living and fossil polychæte is typical of Janjukian strata, and sparingly found in the basal Kalimnan beds. |
| *Spirorbis heliciformis*, Eichwald | Specimens of the above have been recorded from the Miocene of Austria and Russia. It occurs in all probability in the Janjukian limestone of King Island, Bass Strait. In the bores it is common both to Janjukian and Kalimnan strata. |

| | |
|---|---|
| Polyzoa .. .. .. | About 43 species and varieties were noted from the Janjukian, some of them excessively common, especially in the white polyzoal limestone. Amongst these common forms may be mentioned :—<br>*Cellaria acutimarginata*, MacGill.<br>,, *acutiloba*, Busk sp.<br>,, *australis*, MacGill.<br>,, *contigua*, MacGill.<br>,, *rigida*, MacGill., and vars. *perampla*, Waters, and *venusta*, MacGill.<br>*Lunulites canaliculata*, MacGill.<br>*Selenaria cupola*, T. Woods.<br>,, *marginata*, T. Woods, and vars. *lucens*, MacGill., *pulchella*, MacGill., and *spiralis*, Chapm.<br>*Macropora clarkei*, T. Woods sp.<br>*Tessaradoma elevata*, Waters sp.<br>,, *magnirostris*, MacGill.<br>*Lepralia elongata*, MacGill.<br>*Bipora philippinensis*, Busk sp.<br>*Smittia tatei*, T. Woods sp.<br>*Porina gracilis*, M. Edw. sp.[1]<br>*Cellepora fossa*, Haswell sp.<br>,, *gambierensis*, T. Woods<br>,, *tridenticulata*, var. *nummularia*, Busk.<br>*Retepora* spp., indet. |
| *Terebratulina flindersi*, Chapm. | This has also occurred at Flinders, and is a restricted Janjukian fossil. |
| *Terebratella acutirostra*, Chapm. | A Janjukian form related to *T. woodsi*, Tate, which has a more extended range, namely, into the Kalimnan. |
| *T. portlandica*, Chapm. .. | This Janjukian brachiopod also ranges into the next stage, and belongs, like the former species, to the *T. woodsi* group. |
| *Magasella lunata*, Tate .. | Confined to the Janjukian of the bores. It is interesting on account of its previous occurrence in some bores in South Australia, viz., the Croydon bore, 400–1,230 feet, and the Murgurdawa bore at 213 feet. |

[1] The lobed, bilaminate form is here the most usual. On the other hand, MacGillivray says, in Tert. Polyzoa Vict., 1895, p. 103 :—"The lobate form is that usually found recent, while the great majority of the fossil specimens are cylindrical."

| | |
|---|---|
| *Glycimeris maccoyi*, Johnston sp. | A full examination of a large series of the above fossils, compared with other examples from our principal Cainozoic horizons, both in Victoria and Tasmania, shows some interesting mutations or steps in development from the comparatively small shell of the Balcombian, through the massive Miocene form, and merging off in New Zealand seas as the living *G. laticostata*, with the small variant found in the Kalimnan, which links on to *G. subtrigonalis*, Tate, of that formation. |
| *Trigonia lamarcki*, Gray .. | Occurs here about the summit of the Janjukian, and for the first time as a fossil. It is now confined to latitudes not farther south than Port Jackson. A Kalimnan offshoot of this species occurs in *Trigonia howitti*. |
| *Pecten murrayanus*, Tate .. | Found practically throughout the southern Australian Tertiaries, and is well represented in the borings at Janjukian and Kalimnan horizons. It has apparently undergone no marked change for the whole of the great Tertiary period, since it is represented by the almost identical species *P. leopardus*, Reeve (W. and N. Australia and New Caledonia); *P. solaris*, Born sp. (China Seas and Amboyna); and *P. kuhnholtzi*, Bernardi (New Caledonia). |
| *Arcoperna scapha*, Verco .. | It is extremely interesting to find this living species of South Australia, Victoria and New South Wales represented in the bore for the first time as a fossil, in undoubted Janjukian (Miocene) strata. |
| *Condylocardia tenuicostæ*, Chapm. and Gabr. | This striking little species is newly described from the bore, and occurs apparently at the top of the Janjukian series. It is related in some respects to the living *C. pectinata*, Tate and May sp. |
| *Rochefortia donaciformis*, Angas sp. | This is a living species on the coast of Victoria, Tasmania and New South Wales. It occurs in the bores for the first time as a ossil, in the polyzoal rock (Janjukian). |

*Turritella circumligata*, Verco — This mollusc is still living on the coast of South Australia, and has been dredged at 110 fathoms. In the present bore it probably occurs near the summit of the Janjukian.

The series of ostracoda here determined and described contains a large percentage of forms still living. Of the Janjukian species persisting into modern times are—

*Argillœcia badia*, G. S. Brady.
*Macrocypris decora*, G. S. Brady sp.
,, *tumida*, G. S. B.
*Bairdia amygdaloides*, G. S. B.
,, *australis*, Chapm.
*Cythere canaliculata*, Reuss sp.
,, *crispata*, G. S. B.
,, *dasyderma*, G. S. B.
,, *dictyon*, G. S. B.
,, *lactea*, G. S. B.
,, *lepralioides*, G. S. B.
,, *lubbockiana*, G. S. B.
,, *militaris*, G. S. B. sp.
,, *normani*, G. S. B.
,, *obtusalata*, G. S. B.
,, *ovalis*, G. S. B.
,, *parallelogramma*, G. S. B.
,, *rastromarginata*, G. S. B.
,, *scabrocuneata*, G. S. B.
,, *scintillulata*, G. S. B.
,, *scutigera*, G. S. B.
,, *wyville-thomsoni*, G. S. B.
*Loxoconcha australis*, G. S. B.
*Xestoleberis margaritea*, G. S. B. sp.
,, *variegata*, G. S. B.
*Cytherella lata*, G. S. B.
,, *polita*, G. S. B.
,, *pulchra*, G. S. B.
,, *punctata*, G. S. B.

These 29 spp. constitute 76 per cent. of the total ostracodal fauna (38 spp. and vars.).

*Scalpellum subquadratum*, Chapm. — This barnacle is closely related to one found in the Eocene of the London basin and at Bognor, in Sussex, England. Curiously enough, it also resembles in the shape of its carina, a species occurring in our Victorian raised beaches, and presumably of a living form which I have not yet been able to determine.

The teeth of fishes are conspicuous in the Janjukian fauna of the bores, and mostly belong to well-known Australian genera as *Cestracion*, *Galeocerdo*, *Lamna*, *Carcharodon*, *Myliobatis*, (?) *Chrysophrys*, and *Diodon*. The fragments of chimæroid teeth seem to belong to *Edaphodon*, already recorded from the Australian Cainozoic fauna.

A tooth of *Trygon* allied to Probst's *T. rugosus* is amongst the most interesting of the finds, and showing the wide distribution of this sting-ray in neogene times.

## Fauna of the Kalimnan Series.

The foregoing Janjukian series passes, in these boring samples, into beds containing first a mixed fauna (Janjukian and Kalimnan), and then into typical Kalimnan beds. The glauconite sands and marls appear to express a passage series containing the two formations, and these pass up into true Kalimnan shell-marls with *Glycimeris* and *Limopsis*. Generally speaking, the Kalimnan of the Mallee is, like that of the Hamilton area, of fairly shallow-water origin, but in some cases, as in Bore No. 5, there are indications of a deeper water facies. The genera usually represented in the Kalimnan of the bores are such as are found on rocky shores or shallow sandy flats; but occasionally much deeper water conditions may have prevailed, as seem to be shown by some brachiopods (*Terebratulina*), the smaller mollusca, the ostracoda (*Krithe*) and the foraminifera (*Nodosaria*, *Frondicularia*, and *Uvigerina*).

Among the more noteworthy Kalimnan fossils of the borings we may cite the following :—

| | |
|---|---|
| *Ammodiscus ovalis*, Chapm... | This form is a depauperated modification of species like *A. robertsoni*, H. B. Brady sp., and *A. auriculus*, Chapm. The Carbopermian specimen from Pokolbin, New South Wales, figured as *Ammodiscus* sp., should be referred to this form. |
| *Polystomella striatopunctata*, F. and M. sp., var. *evoluta*, Chapm. | This variety of a well-known living species of foraminifer is probably indicative of shallow water. A closely allied variation is that figured by Heron-Allen and Earland as var. *selseyensis*, from the Pleistocene of Selsey, England. This is evidently an instance of the dual divergence of a widely distributed type form, producing almost identical results. |
| *Holcotrochus crenulatus*, Dennant | This neat, simple coral was hitherto known only as a living form, at Cape Borda and St. Vincent's Gulf, South Australia. |
| *Bathyactis beaumariensis*, Dennant | This is a good zone fossil, as it is practically restricted to Kalimnan beds in Victoria. |
| *Lissarca rubricata*, Tate sp. .. | The occurrence of this little species in the Mallee bores is its first record in the fossil state, the horizon being Kalimnan. |
| *Crassatellites kingicoloides*, Pritchard | A species characteristic of the Jemmy's Point beds, Gippsland, and lately recognised by Mr. C. J. Gabriel and the writer in the Beaumaris beds. This occurrence, along with that of *Turritella pagodula*, another Jemmy's Point fossil, seems to indicate an open communication with the Gippsland and Port Phillip Kalimnan sea, rather than with that of the Hamilton area, from which locality these species are absent. |

| | |
|---|---|
| *Cuna concentrica*, Hedley .. | This species is living off the coast of New South Wales; it is its first occurrence as a fossil. |
| *Cardita calva*, Tate .. | This is one of the commonest and most striking bivalves of the Kalimnan. It is identical with the living form found off the South Australian coast and named *C. dilecta*, var. *excelsior* by Verco. |
| *Donax kenyoniana*, Chapm. and Gabr. | A new species of the Kalimnan fauna and quite distinct from the living form *D. deltoides*, Lamarck, and the Cainozoic form from the Murray Cliffs, *D. depressa*, Tate. |
| *Corbula coxi*, Pilsbry. .. | This species was formerly referred to *C. scaphoides*, Hinds; but the latter is more nearly related to *C. ephamilla*, Tate. *C. coxi* is a living species, found off the Victorian coast at Port Phillip, Western Port and Port Albert. |
| *Cadulus acuminatus*, Tate. .. | This species was hitherto confined to the Kalimnan strata of Aldinga. The related species, *C. infans*, is only found at Muddy Creek (upper beds), Hamilton; thus pointing to the partial closure of that area from the "Murray Gulf" in Kalimnan times by the granite and porphyry cliffs of that part of south-western Victoria. *C. acuminatus* is still living around the coasts of New South Wales, Victoria and South Australia. |
| *Liotia dennanti*, Chapm. and Gabr. | This species is either Kalimnan or Janjukian in the Mallee bores, occurring in a mixed sample. Its range appears to extend down to the Balcombian. It is allied to a living species, *Liotia mayi*, Tate. |
| *Euchelus baccatus*, Menke sp. | Occurs in a mixed Kalimnan and Janjukian sample. It is a common living species around the Victorian coast. |
| *Clanculus* aff. *aloysii*, T. Woods | Allied, if not identical with, the common living Australian species to which it is here tentatively referred. Probably Kalimnan. |
| *Teinostoma depressula*, Chapm. and Gabr. | One of the new and entirely distinct species from the Mallee bores. It is typically Kalimnan in age. |
| *T. pulcherrima*, Chapm. and Gabr. | The above remarks apply also to this form. |

| | |
|---|---|
| *Cyclostrema homalon*, Verco | This is a Kalimnan species in the bore, and here recorded fossil for the first time. It has persisted to the present day, being found off the coasts of Victoria and South Australia. |
| *C. harriettæ*, Petterd .. | Also recorded fossil for the first time. Living on the coasts of Victoria and Tasmania. |
| *Eulima pinguicula*, Chapm. and Gabr. | A Kalimnan fossil, quite distinct in specific characters, and showing a relationship to *Eulima inflata*, Tate and May, a form living off the coasts of Victoria and Tasmania. |
| *Pyramidella jonesiana*, Tate sp. | This species was described by Tate from Werrikooian specimens obtained from the Tintinarra bore, South Australia. It is here typically a Kalimnan fossil, although appearing to range a little above and below that horizon. |
| *Turbonilla weeahensis*, Chapm. and Gabriel | This is a new and quite distinct form of the genus. |
| *Calyptræa kalimnæ*, Chapm. and Gabr. | A new form found in the borings both of the Mallee and the Gippsland Lakes, occurring in the Kalimnan series. In the former locality it probably commences at a slightly lower horizon. |
| *Natica subinfundibulum*, Tate, var. *crassa*, Tate | This is a gigantic example of the variety *crassa*, originally described by Tate from Muddy Creek, Beaumaris, and the Murray Cliffs. The present example has a length of 50 mm. against Tate's example with 20 mm. |
| *Rissoa gatliffiana*, Chapm. and Gabr. | A new Kalimnan species of quite distinct characters. |
| *Rissoa* (*Onoba*) *bassiana*, Hedley | This species was previously known as a living form off Devonport, Tasmania, and from Port Albert, Victoria. It occurs here as a fossil for the first time, in Kalimnan beds. |
| *Rissoa* (*O.*) *chrysalida*, Chapm. and Gabr. | A characteristic Kalimnan form. It was previously named in MS. by Mr. Dennant from Muddy Creek (upper beds), where it is a fairly common fossil. |
| *Turritella pagodula*, Tate. .. | A distinctly Kalimnan shell. Previously recorded from the Gippsland Lakes, Beaumaris and Horsham. It is absent from Muddy Creek (upper beds). It is a fairly common fossil in the Mallee bores. The distribution points to the partial isolation of the Hamilton area in Kalimnan times. |

| | |
|---|---|
| *Cerithium torrii*, Tate, and *Cassis contusa*, Tate | Both of these species were, curiously enough, first found in a deep well boring at Tareena, on the Murray, in New South Wales, just across the Victorian border. They occur in the Mallee bores at a Kalimnan horizon. |
| *Cassis* (*Semicassis*) *subgranosa*, Tate sp. | Hitherto only known from one locality —Edithburg, Yorke's Peninsula, South Australia, in "hard, raggy, limestone"; also of Kalimnan age. |
| *Nassa spiraliscabra*, Chapm. and Gabr. | A very distinct form in the Kalimnan of the bores. Its nearest ally is the living *N. labecula*, Adams. |
| *Marginella præformicula*, Chapm. and Gabr. | Nearest allied to the living *M. formicula*, Lamarck, to which it shows ancestral relationship. |
| *Terebra profunda*, Chapm. and Gabr. | A new and distinct species from the Kalimnan. |
| *Pleurotoma* (*Drillia*) *dilectoides*, Chapm. and Gabr. | This species shows affinities towards *P.* (*D.*) *dilecta*, Hedley, a form living in moderately shallow water in the neighbourhood of Port Jackson. |
| *Macrocypris decora*, G. S. Brady sp. | This ostracod belongs to a living species. The examples from the borings dating probably from Upper Janjukian times (Miocene), show colour markings almost as distinct as in recently dredged specimens. |
| *Krithe eggeri*, Chapm. .. | This belongs to a deep-water genus. Its occurrence at a Kalimnan horizon is rather remarkable, and points to the probable variation in depths at which these deposits were laid down. |

The species of living ostracoda first appearing in Kalimnan times in the Mallee deposits are—

*Cythere demissa*, G. S. Brady.
*Xestoleberis curta*, G. S. B. sp.

## Fauna of the Werrikooian Series.

The majority of the fossils from this stage in the bores are comprised in the group of the Foraminifera, many of which range down to the basal Janjukian beds.

There are also some spicules of calcisponges from this stage in bore 11, as well as indeterminable echinoid spines and plates, and an ostracod of a living species, *Cythere rastromarginata*, G. S. Brady, which species extends downwards into Kalimnan, and probably Janjukian, beds.

## 10. STRATIGRAPHICAL NOTES ON OTHER BORINGS THROUGH THE CAINOZOIC SERIES EXAMINED IN RELATION TO THE PRESENT WORK.

### The Murray Basin, Victoria.

*Maryvale, near Goroke.*

This is a private boring made by Mr. C. W. Chapman, to whom the National Museum is indebted for a series of shells from one of the samples (13.1.09) The bore was put down at Maryvale, 12 miles south of Goroke.

Fossils obtained from this bore at about 140 feet indicate a mixture of Kalimnan (Lower Pliocene) and Werrikooian (Upper Pliocene) horizons.

| Name of Fossil. | Initial of Horizon. |
|---|---|
| *Arachnoides* (*Monostychia*) cf. *australis*, Laube sp. | K. |
| *Cellepora* sp. | |
| *Nucula obliqua*, Lamarck | K.W. |
| *Leda acinaciformis*, Tate | K. |
| *Limopsis* sp. | |
| *Glycimeris halli*, Pritchard | K. |
| *Placunanomia ione*, Gray | K. |
| *Mytilus deperditus*, Tate | K. |
| *Venus* (*Chione*) *propinqua*, T. Woods sp. | K. |
| ,, ,, *subroborata*, Tate sp. | K. |
| *Mactra hamiltonensis*, Tate | K. |
| *Barnea tiara*, Tate | K. |
| *Astralium* cf. *aureum*, Jonas sp. | W. |
| *Bankivia fasciata*, Menke sp. | W. |
| *Liopyrga quadricingulata*, Tate | K. |
| *Calyptræa crassa*, Tate | K. |
| *Natica cunninghamensis*, Harris | K. |
| *Nassa crassigranosa*, Tate | K. |
| ,, *sublirella*, Tate | K. |
| *Latirus approximans*, Tate sp. | K. |
| ,, *purpuroides*, Tate sp. | K. |
| *Ancilla orycta*, Tate sp. | K. |
| *Terebra catenifera*, Tate | K. |
| *Marginella muscarioides*, Tate | K. |
| *Volutilithes* sp. | |

It is of interest to note the presence of the gasteropod *Ancilla orycta* in this locality, since it has been previously recorded only from the Bairnsdale district, Victoria, and from Aldinga, South Australia. It is absent from the Mallee bores.

*Nhill, No.* 51.[1]

The depth of this boring is 1,172 feet. The reduced level of the surface of the ground above sea-level is 423 feet, and the reduced level of the bottom of the bore is −749 feet.

Fresh water was struck at a depth of 100 feet from the surface.

[1] Numbers assigned by Water Supply Commission to this and other bores in the Murray basin here quoted.

The data regarding the rocks passed through in the boring, as given in "Report *re* Boring for Artesian Water in the Mallee," by R. L. Jack, J. Stirling, and E. Checchi, (1897), are as follows :—

Middle Tertiary limestone[1], 200–460 feet.
Sandstones, clays, and lignites of Middle Tertiary age[2], 460–1,080 feet.
Bedrock struck at 1,172 feet.

A sample of rock from 332–380 feet (Nhill Water Trust bore), which I examined, is seen to be polyzoal rock (Janjukian), with :—

*Cellepora* sp.
*Lovenia forbesi*, T. Woods sp.
*Mopsea tenisoni*, Chapm.
*Ditrupa cornea*, L. var. *wormbetiensis*, McCoy; (abundant).

*Netherby, No.* 53.

The depth of this boring is 2,200 feet.

The reduced level of the surface of the ground above sea-level is 390 feet. The reduced level of the bottom of the bore is –1,810 feet. Fresh water was struck at 135 feet from the surface.

The official record states[3] that "Middle Tertiary limestone extended from 245 to 657 feet. Clays and lignites of Middle Tertiary age[4] from 657 to 978 feet. Sandstones, shales, and conglomerates (? Upper Palæozoic) from 978 to 2,175 feet. 'Porphyry' was cut between 2,175 and 2,200 feet."

A sample of the fossiliferous limestone from the above boring from 410 ft. 1 in. is in the Museum collection. An examination of the fossils show the following to occur at that depth :—

Polyzoa, indet.
*Terebratulina suessi*, Hutton sp.
*Nucula atkinsoni*, Johnston.
*Trigonia semiundulata*, Jenkins.
(?) *Cucullæa corioensis*, McCoy.
*Limea transenna*, Tate.
*Cuspidaria subrostrata*, Tate sp.
*Myodora australis, Tate.*
*Venus* (*Chione*) *cainozoicus*, T. Woods sp.

The above list does not show any especially restricted fossils, for all of them have a rather extensive vertical range, being characteristic of the Barwonian series (*i.e.*, Balcombian + Janjukian). At the same time one notices that the species are more typically Janjukian than Balcombian, and, considering the evidence of the faunas of the bores in the proximity, this points to the conclusion that they belong to the Janjukian.

*Walpeup, No.* 21.

Reduced level of surface of ground above sea-level, 213 feet. Depth of bore, 852 feet. Reduced level of the bottom of bore –639 feet.

Upon a sample of this bore at 802 feet being submitted to me by Mr. A. S. Kenyon, I reported as follows (13th May, 1910) :—

"The sample of the Walpeup bore at 802 feet shows that the glauconitic sandy bed has been struck, which, in the Kow Plains series, was met with at about 200 feet. This present evidence points to a considerable thickening of the Tertiary series going northward, corresponding with the theory of a

---

[1] Probably Janjukian.
[2] Probably equivalent to the dark, carbonaceous clays with quartz grit of the Aire coast.
[3] Report *re* Boring, etc., Jack, Stirling and Checchi, 1897, p. 3.
[4] Probably the same as the Aire Coast phase of Janjukian age.

great bight in Middle Tertiary times, running up into Victoria and New South Wales, and comprising the Darling, Lachlan, Murrumbidgee and Murray basins.

This deposit looks promising for water, since in bore No. 3 (Mallee) it was met with soon after passing through a similar bed."

The fossils found in the washings at this depth are —

Foraminifera—

*Miliolina vulgaris*, d'Orb. sp.
*Clavulina angularis*, d'Orb.
*Truncatulina reticulata*, Czjzek sp.
*Pulvinulina elegans*, d'Orb. sp.

Polyzoa—

*Entalophora australis*, Busk. A species found hitherto as a fossil in the Balcombian of Muddy Creek, and also living on the Australian coast.

Although nothing of a restricted kind appears amongst these fossils, the quantity of broken polyzoa and the richness of the microzoic fauna (unfortunately much water-worn and specifically unidentifiable), shows this sample to be well down in the Tertiaries.

### *Tiega Bore, No.* 22.

The reduced level of the surface of the ground above sea-level is 176 feet. Depth of bore, 1,040 feet. Reduced level of the bottom of the bore – 864 feet.

This bore is situated a little to the north-east of Walpeup, and is due south from Yatpool. Water was struck at various levels in this bore; all the samples are salt. From an examination of the engineer's report, the Recent to Werrikooian appears to extend down to 286 feet, when probable Kalimnan blue clays with shells are in evidence. This series may extend to 399 feet, when polyzoal rock occurs down to 766 feet. After this, the dark-coloured carbonaceous clays and sands occur throughout. From the fact that the upper beds in the line of bores shown in Fig. 42 show a parallelism in the thickness of the strata, it is clearly demonstrated that this brown clay series of the Tiega bore is in part comparable with the polyzoal rock of the preceding bore (Walpeup) at 800 feet or thereabout. This Janjukian age of the carbonaceous clays has since been confirmed by the detailed examination of a sample from 770 feet in this series, containing numerous examples of *Pulvinulina scabricula*, a restricted Janjukian species, and also fragments of *Trigonia lamarcki*, met with elsewhere at the top of the Janjukian.

### *Yatpool, near Mildura, No.* 68.

Reduced level of surface of ground above sea-level, 162 feet. Depth of bore, 1,410 feet.

A sample of this boring from about 450 feet was submitted to me, 5th December, 1911, and I reported to Mr. A. S. Kenyon as follows :—

"This sample yields about ten fossils, none of which are restricted to particular horizons, though they are commonest in the Spring Creek fauna. The rock and fossil contents resemble the stiff clays found above the water-bearing strata in the earlier bores (Nos. 1–11), so that the chances of striking water by deepening the present bore are rather favourable than otherwise."

Subsequently fresh water was struck at 900 feet.

Since writing the above note the occurrence of *Pyramidella jonesiana* was noted, which adds a Kalimnan feature to this fauna at 450 feet.

Fossils at about 450 feet—

*Bathyactis lens*, Duncan sp.
*Cellepora* sp.
*Leda huttoni*, T. Woods.
,, *woodsi*, Tate.
*Dentalium aratum*, Tate.
*Pyramidella jonesiana*, Tate sp.
*Nassa tatei*, T. Woods.

Fossils at 800 feet—

Polyzoal rock, containing—
*Porina gracilis*, M. Edw. sp.
*Entalophora*, sp.
*Retepora* sp.
*Cellepora* sp.

From information derived by an inspection of the engineer's report of the boring I find that at Yatpool the base of the Janjukian at about 842 feet rests on brown clay. The top of the Janjukian appears to be reached at 557 feet, whilst the top of the succeeding fossiliferous beds, the Kalimnan, are touched at about 329 feet. Thus the Kalimnan may be 228 feet thick, and the Janjukian 285 feet. These numbers are to be taken as provisional since no fossils were examined beyond those indicated above.

## Notes on the foregoing Bores.

From Maryvale to Yatpool the bores shown as above are roughly speaking in a line north 20° east. Although the evidence of some of these bores is very imperfect, yet on the whole the following interesting data may be gleaned.[1] Viewed against the line of reduced levels, the ground-surface from Maryvale gradually slopes from 532 feet to 162 feet at Yatpool. From Maryvale to Netherby the Kalimnan beds run at almost equal depths below the surface, about 150 to 200 feet below ground level. Thence to Yatpool there is a slightly steeper slope, at the latter locality the Kalimnan coming in at 325 feet below the ground surface.

### *Mt. Gnarr. Mallee Bore, No.* 16.

This series has not yet been examined in detail, but the following notes are given as of preliminary importance.

The superficial deposits are yellow and ochreous sands and stiff clays.

At 160 feet a coarse quartz grit occurs.

Shelly Kalimnan clays are seen at 340 feet.

The polyzoal rock series occurs about 470 feet. At 730 to 740 feet there is a whitish, marly rock, full of vesicles. The sample of 740 to 750 feet is a dark, basaltic-looking rock, and similarly vesicular. Wishing for an independent opinion on this rock I placed a specimen in the hands of Mr. D. J. Mahony, M.Sc., Petrologist to the Geological Survey, and he kindly favoured me with the following note :—" I found that the material easily breaks down in water, unlike decomposed basalt, so washed off the finer parts and mounted the residue on the slide sent herewith. This residue consists largely of quartz, with some ferro-magnesian minerals and organic remains, including foraminifera, so that there can be little doubt that the material is part of an aqueous deposit, and that the vesicular, bread-like structure is due to some peculiar conditions prevailing during its deposition—possibly the formation of gas bubbles."

1. See fig. 42, p. 408.

## Borings in the Adelaide Basin.

These show some remarkable differences in the comparative levels of each horizon, in borings removed from one another by only a few miles. The data given below are taken from accounts of the earlier bores already published, with annotations respecting the various horizons met with, as viewed in the light of these later investigations.

### *Kent Town Bore.*[1]

The level of the surface is 138·83 feet above low-water mark.

| Depth. | Horizons. | |
|---|---|---|
| | Tate. | Chapman. |
| 0–2 | Recent surface accumulations | Holocene to Werrikooian. |
| 2–69 | Pliocene loams and gravels | |
| 69–218 | Marine Miocene .. .. | Kalimnan. |
| | | Janjukian. |
| 218–360 | Lacustrine Miocene .. | Janjukian (similar carbonaceous, sandy beds are met with in the Murray basin, and are probably comparable with those of the Aire coastal bed in Victoria). |
| 360–411 | Pre-Silurian (felspathic quartzite, slaty rock and fine-grained sandstone). | |

Water was struck in a white quartz sand overlying the marine Tertiary beds at 69 feet.

### *Croydon Bore.*

This is situated 3½ miles from Adelaide. Two borings were made. No. 1 attained a depth of 800 feet; No. 2, 2,296 feet.

Older Pliocene strata were found in Bore 2 at 603–606 feet, and at 705–715 feet. From 970–1,681 feet the Janjukian or polyzoal rock facies is in evidence.

Palæozoic rocks were met with at 2,262–2,296 feet.

The list of fossils given by Prof. Tate[2] from this bore at 970–1,681 feet is interesting for comparison with a nearly identical fauna in the Victorian Mallee bores.

"*Turritella aldingæ*, Tate.
*Mesalia stylacris*, Tate.
*Dentalium mantelli*, Zittel.
,, *subfissura*, Tate.
*Dimya dissimilis*, Tate.
*Lima bassi*, T. Woods.
*Pecten eyrei*, Tate.
,, *flindersi*, Tate.
,, *hochstetteri*, Zittel.

[1] Trans. Roy. Soc. S. Aust., Vol. XXII., 1898, p. 196.
[2] For the details of this bore, *see* Tate, R., Trans. Roy. Soc. S. Aust., Vol. V., 1882, pp. 40–43.

*Terebratulina catinuliformis*, Tate.
*Magasella lunata*, Tate.
*Magellania garibaldiana*, Dav.
*Fibularia gregata*, Tate.
*Scutella marsupiata*, sp. nov.; probably = *Echinocyamus* (*Scutellina*) *patella*, Tate sp., marsupiate var.
*Echinolampas murrayanus*, Laube.
*Pentacrinus*.
*Antedon*.
*Graphularia senescens*, Tate sp."

Prof. Tate gives the geological equivalents of the strata passed through as follows :—

| | |
|---|---|
| "Mammaliferous drift .. .. .. | 395 feet. |
| Older Pliocene .. .. .. | 395–715 feet. |
| Eocene ? (Marine) .. .. .. | 715–760 ,, |
| Eocene (Marine) .. .. .. | 760–1,681 ,, |
| Eocene (unfossiliferous) .. .. | 1,681–2,262 ,, |

The first series to 395 feet probably represent Recent to Werrikooian; 395–715 ft. = Kalimnan strata; 715–1,681 ft. = Janjukian; and 1,681–2,262 ft. = Janjukian (fluviomarine).

A note on bore 1 by Prof. Tate[1] gives details of the fossiliferous contents of the material, and shows, by its intermixed faunal characters in samples at 455–572 feet, that there was a probable inclusion of material worked in from higher levels, *i.e.*, Kalimnan.

*Dry Creek Bore, 5 miles from Adelaide.*

The bore was put down to 410 feet. So far as one can judge from the deta ils and contents of this bore,[2] the following is the sequence of strata :—

| | |
|---|---|
| 0–320 feet .. | Sands and clays. Holocene to Werrikooian. |
| 320–400 feet .. | Clay with shells. Kalimnan and some Werrikooian admixed. |
| 400–410 feet .. | Sands and quartzite pebbles. |

The foraminifera recorded by Mr. Howchin in the paper by Prof. Tate mentioned below (p. 177) are Kalimnan and Recent, as shown by the mollusca.

## NOTES ON THE BORES OF THE ADELAIDE BASIN.

The conditions under which the above deposits were formed closely agree with the conditions which prevailed in the Port Phillip area towards the latter part of the Tertiary period, as revealed by the boring at Sorrento. In both areas—the Adelaide and the Port Phillip basins—during the Pleistocene there was a steady and continuous depression of the shore-line, resulting in the deposition of from 300 to 400 feet of comparatively recent shallow-water shell-muds and sands.

The great thickness of the Tertiaries in the Croydon bore as compared with that of Kent Town can only be accounted for, as Mr. Howchin has already shown,[3] by the earth movements and step-faulting, resulting within the distance of a few miles of a difference in the vertical thickness of the Tertiary sediments of nearly 2,000 feet.

Prof. Tate sought to explain this difference in thickness[4] by assuming that the Kent Town series was of a later period, and more littoral in organic contents. Howchin's work on the foraminifera of this bore, however, shows

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[1] Trans. Roy. Soc. S. Aust., Vol. XIII., 1890, p. 184.
[2] *Ibid.*, p. 172.
[3] Rep. Aust. Ass. Adv. Sci. Melbourne meeting (1913), 1914, p. 161.
[4] Trans. Roy. Soc. S. Aust., Vol. XXII., 1898, p. 196.

unmistakeably that the Janjukian was reached at depths after 69 feet and down to 218 feet.[1] In the Croydon bore the Kalimnan stage is seen between 603 and 715 feet, and the Janjukian from 970 to 1,681 feet. This extraordinary difference of levels cannot, to my mind, be ascribed to an accumulation formed in front of a submarine escarpment in the case of the Croydon bore and a layer of younger sediments on the Kent Town platform, for the latter shows the entire series from Janjukian to Recent as in the Croydon bore. In fact, the case is actually paralleled in the Sorrento bore, where 1,700 feet of sediments have been long and persistently lowered in front of the Cape Schanck to Dandenong fault; whilst in the latter case the upthrow side seems to have been positively elevated between Balcombian and Janjukian times, otherwise marine sediments of the latter period would be more in evidence. This elevation seems to have persisted to the present day as shown by the thick ironstone cover upon the Balcombian marine shell-marls on the east side of Port Phillip.

## Borings in the Murray Basin of South Australia.

The boring samples of later date than the Ki Ki bore and Tintinarra do not seem to have been examined in detail. I am indebted to Mr. A. S. Kenyon, C.E., for samples from the Cotton, Geranium, and Rosy Pine bores. On a cursory examination these show, as might be expected, very similar characters to those enumerated and described in the body of this report.

### *Tintinarra Bore.*

This bore is situated in the Ninety Mile Desert, near the Tintinarra railway station. The approximate height of the surface above sea-level is 62 feet. The depth of the bore is 253 feet. Salt water was struck at 14 feet and fresh water at 251 feet. The supply was artesian when first tapped.[2]

The fossils from this bore show, by Prof. Tate's list, that there has been a considerable admixture of samples. The prevailing series, from the data supplied by Tate,[3] seem to be the Werrikooian and Kalimnan, probably ranging from 26–244 feet. The occurrence of *Bankivia fasciata* at 244 feet, along with *Leda crassa*, shows the presence, even at that depth, of a mixed Werrikooian and Kalimnan fauna. There appears to be no evidence amongst these fossils that Janjukian strata were touched in the bore, although Prof. Tate records on p. 67 (*loc. cit.*) "Eocene (marine) blackish-brown sand (with numerous fossils), 244–253 feet."

From the great thickness of the Werrikooian shown in this bore the locality seems to be situated in an area which was sinking from at least Kalimnan times, forming a wide trough into which marine and estuarine shells were drifted. Assuming it to be a rift-valley of late Tertiary age, it is probably connected with the occurrence of the abnormal thickness of silty material found in Bore 9 in the Mallee from 90 to 253 feet. The drowned rift-valleys of Spencer Gulf and Gulf St. Vincent may belong to the same system.

### *Ki Ki Bore, South Australia.*[4]

Four miles west of Coonalpyn, in the Murray basin in South Australia. The so-called Eocene sands at a depth of 380 to 424 feet have a fauna containing several restricted Aldingan (=Janjukian) fossils, as *Cypræa ovulatella*, Tate; *Scala mariæ*, Tate sp.; and *Turritella aldingæ*, Tate.

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[1] Trans. Roy. Soc. S. Aust., Vol. XIV., 1891, p. 350.
[2] Rep. Geol. Country South and East of the Murray River—H. Y. L. Brown, 1910, pp. 6, 7.
[3] Trans. Roy. Soc. S. Aust., Vol. XXII., 1898, p. 65 *et. seq.*
[4] See Tate. *Ibid.*, Vol. XX., 1896, p. 115. *Id., ibid.*, Vol. XXII., 1898, p. 198.

At 582 feet a presumably Palæozoic rock was met with, described as a "soft reddish-brown argillaceous rock, decomposed." This passed downwards into a soft yellowish-green and very soft dark-green argillaceous and decomposed rock, and finally, at 666 feet, into "hard, green, slaty rock, with quartz."

### The Portland Bore.

A boring in search of coal[1] was put down in the botanic gardens reserve, reaching a depth of 2,265 feet. It ceased in strata containing shell impressions. A second bore was put down near the Surry River to the depth of 1,504 ft. 11 in., ceasing in limestone. No samples of these borings appear to have been preserved, but from the fact that the polyzoal rock at Portland is met with at about sea-level, it may be assumed that the entire depth of the bore was in polyzoal limestone. The cliffs at Portland yield typical Kalimnan fossils, as the following list from a small collection in the National Museum will show :—

*Lovenia woodsi*, T. Woods sp.
*Leda acinaciformis*, Tate.
*Glycimeris halli*, Pritchard.
*Ostrea manubriata*, Tate.
„ *sturtiana*, Tate.
*Corbula coxi*, Pilsbry.
*Liopyrga quadricingulata*, Tate.
*Bankivia* sp.

These fossils are noted on the labels in the collection as occurring in the upper, middle and lower beds of the cliff section, and therefore graduate into the polyzoal limestone of the beds at and below sea-level at Portland. Tenison Woods states[2] that "at Portland Bay, about 50 miles east of South Australia, where the coast action has exposed a fine section, the coralline limestone is seen underneath" the volcanic rock. This "coralline limestone" is the same as the polyzoal limestone of Mount Gambier, and which forms the lower series of the Mallee bores.

### The Sorrento Bore.

This bore was put down for the investigation of the coal deposits in the Cape Schanck peninsula. The geological results obtained from this boring are of the greatest importance, since nearly the whole of the Tertiary beds was passed through, although bed-rock was not reached when boring ceased at 1696 feet.

A preliminary report was furnished by the writer in 1910[3] as follows :—

"From a geological or stratigraphical stand-point this boring is one of the most important ever put down in the State, for it gives the succession of the Tertiary beds in the most complete form obtainable, since in no other spot would there be such a continuous and extremely thick deposit of practically the whole of the Tertiary series.

From the surface to 430 feet the principal rock material is more or less consolidated dune-sand, alternating with occasional limited bands of brown clay. At 489 feet a dark, umber-coloured clay was met with, containing

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[1] Ann. Rep. Sec. for Mines, Victoria, 1895 (1894), p. 60.
[2] Geological Observations in South Australia, 1862, p. 121.
[3] Ann. Rep. Sec. for Mines, Victoria, 1911 (1910), p. 152.

an abundance of *Spisula parva*, Petit sp., a bivalved shell which is still found living in the neighbourhood of Port Melbourne and in similar estuarine conditions at the mouths of rivers and creeks along the Victorian coast. At 585 feet, and down to 730 feet, shelly sand and grit, with fossils of Kalimnan age occur. These beds gradually pass down into the Barwonian series, near the top of which some typical Janjukian species of fossils are found. In the absence of a detailed examination of the cores it is not possible to give the absolute limits of the stratigraphical groups, but it may be remarked that typical Balcombian strata, with bands of the small pteropod fossil, *Vaginella*, which is found a little above sea-level at Grice's Creek and Mornington, and also in the older beds of Muddy Creek, near Hamilton, are here noted from 1,310–1,426 feet in the boring. From that depth to the lowest reached, the core consists of grey marls, with, as far as proved, a general Balcombian facies. Many new species occur in these cores, and the microzoa are especially well represented. The description of these fossil forms will be undertaken in the full report."

## Borings near Bairnsdale.

### *Fernbank Bore.*

This bore is situated close to the Fernbank railway station, which is 272 feet above sea-level. It is a Government bore, put down in conjunction with the Shire Council, as there was no definite water supply in summer, and no good holding ground for the construction of dams or tanks. The water was not struck until a level was reached as low as the lowest creek in the neighbourhood. The total volume of water obtained is very small, but sufficient for the requirements of the locality.

From a sample of fossiliferous material submitted to me by Mr. A. S. Kenyon, and obtained from depths of 337–395 feet, I have determined the following fossils :—

*Sphenotrochus emarciatus*, Duncan.
*Arca* (*Plagiarca*) *cainozoica*, Tate sp.
*Limopsis insolita*, Sow. sp.
*Cardita* aff. *delicatula*, Tate (var. with fewer ribs).
*Turritella tristira*, Tate.
*Murex dennanti*, Tate.
*Volutilithes antiscalaris*, McCoy sp.

From the presence of *Limopsis insolita* the horizon appears to be Janjukian. All the other fossils are unrestricted, that is, they occur both above and below the series named.

### *Paynesville Bore.*

This bore is situated 10 miles from Bairnsdale, only a few feet above the level of the lakes of the district. Water was known to exist below the surface, but was inferior in quality and limited in volume. The water struck in the boring was first met with a few feet below the surface, and increased in volume as the bore was proceeded with. Boring ceased at 512 feet, as at that depth a sufficient volume of water for all requirements had been obtained. A much greater supply would probably be obtained by deeper boring, since the water-bearing strata, like that of the Mallee area, was only just being reached when boring ceased.

From samples of rock submitted by Mr. A. S. Kenyon and from another source, the following lists of fossil determinations have been made :—

At 100 feet pebbles were met with.

At 160–260 feet—

*Limopsis beaumariensis*, Chapm.
*Leda woodsi*, Tate.
*Pecten polymorphoides*, Zittel.
,, *antiaustralis*, Tate.
*Erycina micans*, Tate sp.
*Venus* (*Chione*) *cognata*, Pritch. sp.
*Meretrix tenuis*, Tate.
*Corbula pyxidata*, Tate.
*Turritella tristira*, Tate.
*Marginella wentworthi*, T. Woods.
,, *propinqua*, Tate.
*Ancilla ligata*, Tate sp.
*Terebra catenifera*, Tate.

This series is strongly Kalimnan in aspect, with a slight admixture of Janjukian.

At 212–228 feet—

*Limopsis beaumariensis*, Chapm.
*Trigonia margaritacea*, var. *acuticostata*, McCoy.
*Cardita* sp. nov.
,, *scabrosa*, Tate.
*Turritella conspicabilis*, Tate.
*Bathytoma fontinalis*, Tate sp.

This horizon is Kalimnan, the fauna showing, however, a slight admixture of Janjukian forms.

At 228–234 feet.—

*Cucullæa corioensis*, McCoy.
*Limopsis beaumariensis*, Chapm.
*Spondylus* sp., near *S. gæderopoides*, McCoy.
*Cardita spinulosa*, Tate.

Horizon—mixed Kalimnan and Janjukian.

At 235 feet—

*Bipora philippinensis*, Busk sp.
*Selenaria cupola*, T. Woods sp.
*Glycimeris* cf. *maccoyi*, Johnston sp.
,, *convexus*, Tate.
*Limopsis beaumariensis*, Chapm.
*Lissarca* sp.
*Leda woodsi*, Tate.
*Trigonia margaritacea*, var. *acuticostata*, McCoy.
*Cardita spinulosa*, Tate.
*Condylocardia* sp.
*Lucina nuciformis*, Tate.
*Dosinea* sp.
*Corbula ephamilla*, Tate.
*Turritella*, near *tristira*, Tate.
*Tylospira coronata*, Tate sp.

This horizon is more strongly Kalimnan than Janjukian.

At 242–270 feet—

*Balanophyllia armata*, Duncan.
*Deltocyathus aldingœ*, Dennant.
*Limopsis insolita*, Sow. sp.
*Trigonia margaritacea*, var. *acuticostata*, McCoy.
*Pecten* sp. nov.
*Crassatellites dennanti*, Tate sp.
*Venus* (*Chione*) sp.
*Eulima* sp. nov.
*Tylospira coronata*, Tate sp.

This horizon is more strongly Janjukian than Kalimnan, as shown by the occurrence of *Limopsis insolita* and *Crassatellites dennanti*.

At 265 feet—

*Glycimeris maccoyi*, Johnston sp.
,, *halli*, Pritchard.
*Limopsis beaumariensis*, Chapman.
*Leda woodsi*, Tate.
*Ostrea arenicola*, Tate.
*Trigonia margaritacea*, var. *acuticostata*, McCoy.
*Cardita calva*, Tate.
,, *spinulosa*, Tate.
*Cuna polita*, Tate sp.
*Condylocardia* sp.
*Venus* (*Chione*) *cognata*, Pritch.
*Tellina* sp.
*Corbula ephamilla*, Tate.
*Ischnochiton* sp.
*Dentalium* (?) *subfissura*, Tate.
*Natica polita*, T. Woods.
*Turritella tristira*, Tate.
,, cf. *acricula*, Tate.
*Lotorium* sp.
*Olivella nymphalis*, Tate sp.

This horizon is mixed Kalimnan and Janjukian.

At 330 feet—

*Limopsis beaumariensis*, Chapm.
*Glycimeris maccoyi*, Johnston sp.
*Venus* (*Chione*) sp.
*Dentalium aratum*, Tate.
*Rissoa* sp.
*Eulimella* sp.
Otoliths of teleostean fishes.

Probably a mixed Kalimnan and Janjukian fauna.

At 366 feet—

*Lamna apiculata*, Agassiz. Probably Janjukian.

At 395 feet—

*Harpa tenuis*, Tate.
*Corbula ephamilla*, Tate.

Janjukian.

At 450–512 feet—

*Cellepora fossa*, Haswell sp.
*Magellania insolita*, Tate.
*Spondylus* cf. *gœderopoides*, McCoy.

Janjukian.

## 11. SUMMARY OF SCIENTIFIC RESULTS.

### The Underlying Rocks of the Mallee.

(*a*) *The oldest Beds of the Cainozoic in this Area.*—In bores 1–11, the oldest beds are comparable with the polyzoal rock of the Mount Gambier type, and their fauna shows them to be of Janjukian (Miocene) age. The maximum thickness is 333 feet. That it is a deposit formed under the sea is evident from the occurrence of sharks' teeth, oysters, pectens, sea-urchins and foraminifera. In later borings, as that of Tiega, the polyzoal rock was seen to pass down into carbonaceous sands and clays, probably estuarine in part, and comparable with those found in the Otway Janjukian series.

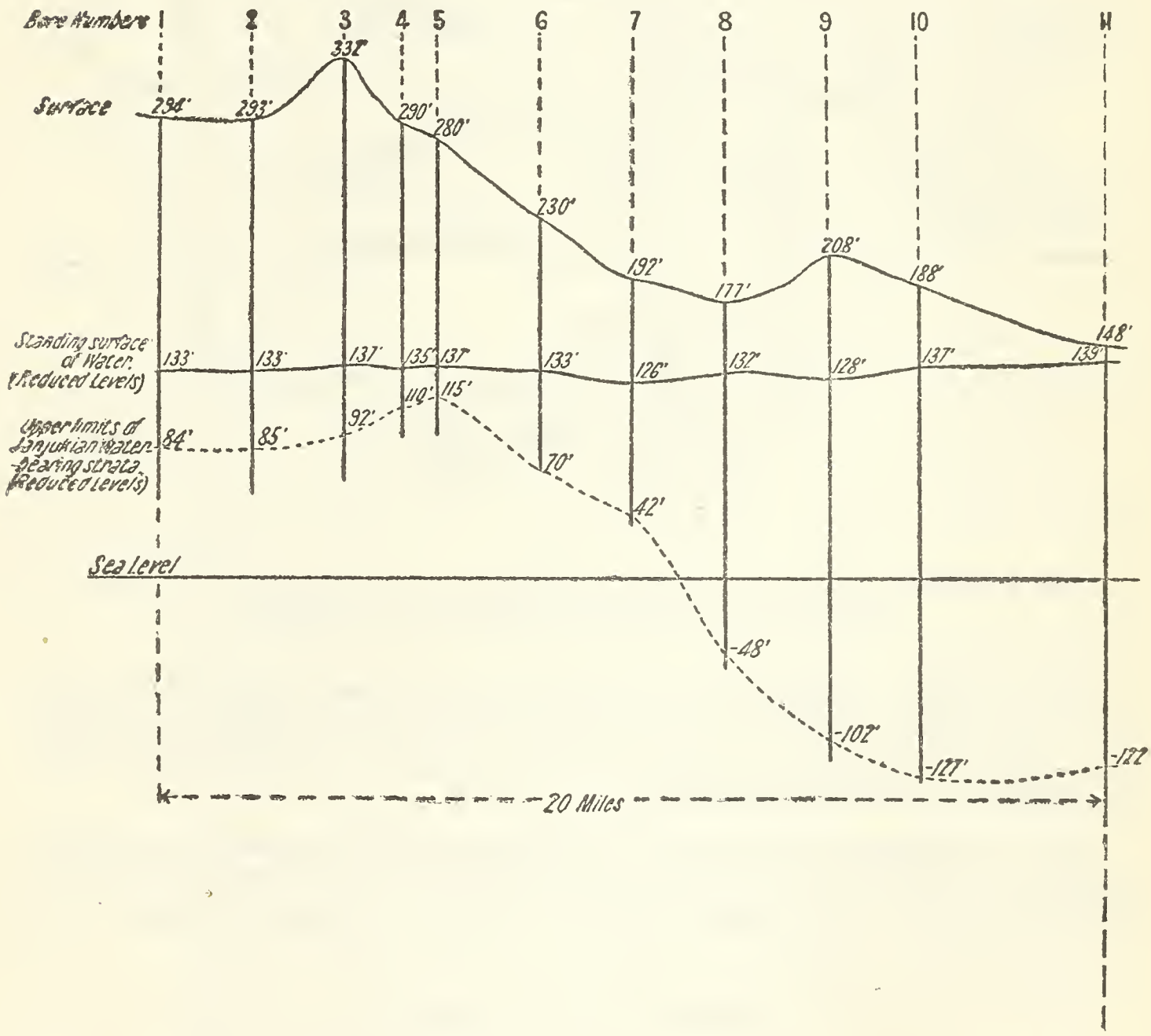


Fig. 40. Section of Bores Nos. 1 to 11, Murrayville.

(*b*) *Later Cainozoic.*—This was proved to be Kalimnan or Lower Pliocene, generally of a shelly and shallow marine (littoral) character. Its maximum thickness is 92 feet. It passes downwards into typical Janjukian beds with no intervening series.

(*c*) *The Werrikooian.*—Probably of Upper Pliocene or Lower Pleistocene age. It is represented in the bores by estuarine sands with foraminifera and occasional mollusca. In one bore, No. 9, this deposit was of great thickness (163 feet), the exceptional accumulation of estuarine sands at this locality pointing to a line of crustal movement or sagging during Werrikooian times.

In one bore (No. 6) an old dune-limestone occurs, probably of this age, denoting the proximity of the shore line at that period, since the rock is largely composed of drifted foraminifera and other marine debris.

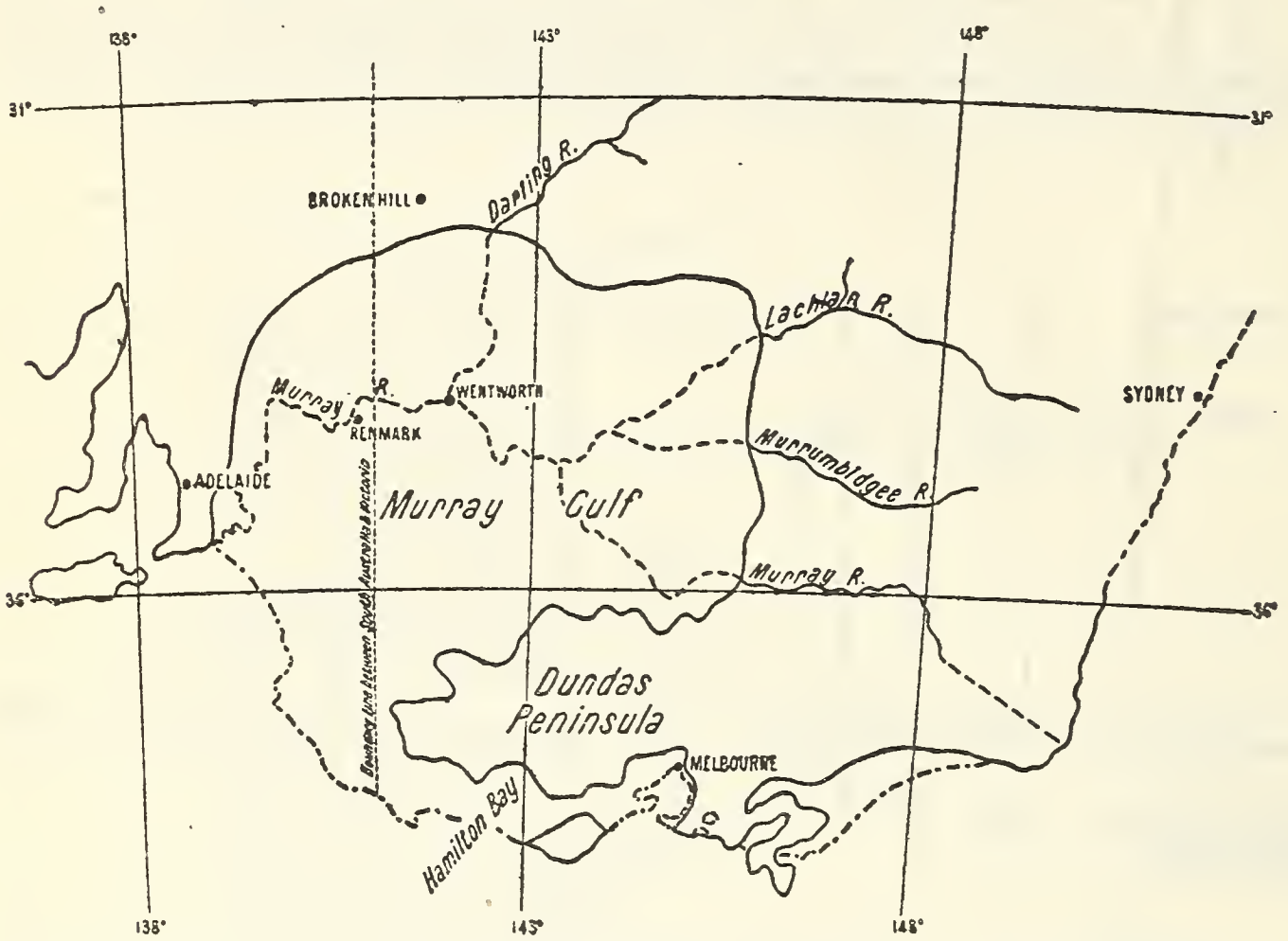


Fig. 41. Sketch map of the Cainozoic Murravian basin and associated areas. Partly based on a map by Professor J. W. Gregory.

(*d*) *The Later Pleistocene and Holocene* of the bores consist of variously coloured sands, sometimes ferruginous, at others pyritous, with concretionary or roughly pisolitic pink and white limestone, evidently formed by the agency of mollusca and algæ in inland lakes.

(*e*) The sequence of the rocks in the bores gives additional and corroborative evidence to that already obtained from the Sorrento bore, where the bulk of the Cainozoics was penetrated without, however, reaching bed-rock.

## Palæontological Results.

(*f*) From these borings an extensive series of fossils was obtained, comprising several thousands of specimens, and referred to 455 species and varieties. Thirty-eight (38) new species and varieties have thus been brought to light and described. All the specimens are duly labelled, and preserved for future reference in the collection at the National Museum.

## Physiographical Results.

(*g*) The bathymetrical evidence of the several faunas shows the Janjukian fossiliferous beds to have been deposited under varying conditions in this great inland gulf; the polyzoal limestone in moderately deep, clear water,

free from much terriginous or land-derived sediment; the glauconitic clays and sands with fish remains in moderately deep water subjected to current action; and blue sandy clays with shells in shallow water.

The Kalimnan deposits generally indicate fairly shallow water, excepting in a few instances where the rock is a fine, blue, shelly clay, with smaller bivalves and gasteropods.

(*h*) Evidence afforded by the presence of localized species, as *Calyptræa kalimnæ* and *Turritella pagodula*, points to more open communication between the Bairnsdale and the Mallee areas, than between the latter and the Hamilton Bay.

### Geological Data from other Borings.

(*i*) Among the extra borings of which detailed results are given in the text, the following may be briefly referred to :—

The Tintinarra bore of the south-western part of the Murray Gulf shows a great thickness of Werrikooian strata, and probably indicates a trough fold or even a rift-valley in this locality with corresponding infilling of marine and estuarine material.

The Portland bore shows a remarkable thickness of Janjukian strata, probably amounting to over 2,000 feet; it seems to be situated over a rift-valley formed by movements prior to the movements of the adjoining Ninety Mile Desert area (Tintinarra) in Werrikooian times.

The Sorrento bore shows a continuous sinking from Balcombian times, and is probably the most complete section of the Cainozoics available in one spot. From Balcombian to Kalimnan times this area appears to have maintained its fairly deep-water aspect, and not until Werrikooian and Pleistocene times does it show a shallowing, when the deposits become estuarine and littoral marine.

The Paynesville bore, and incidentally the Fernbank bore, both in the Bairnsdale artesian basin, show, by an examination of the fossiliferous strata passed through, that the succession of beds is similar to that of the Mallee, and that the polyzoal phase of the Janjukian is replaced by a shelly and gravelly deposit of Miocene age. This Miocene series extends at the Paynesville bore from about 200 to 512 feet, with basal limit not reached; whilst the superimposed Kalimnan occurs from 160 to about 200 feet. As in other localities, the Lower Pliocene is a thinner and quite subordinate deposit. That extensive faulting must have taken place in the Bairnsdale area is evident from the occurrence of Janjukian limestone in the quarries at Sale and outcropping on the banks of the Mitchell, Nicholson and Tambo Rivers, indicating a downthrow at Paynesville of at least 160 feet.

An examination of the brown clay and sand series (carbonaceous) of the Tiega bore sets at rest any doubt as to their Janjukian age, as restricted fossils were found at 770 feet in this series.

## 12. SUMMARY OF ECONOMIC RESULTS.

This series of borings has brought to light some interesting facts bearing on the actual horizons at which a full supply of water may be met with.

(*a*) In all eleven bores examined, a standing surface of water occurred, the levels of which, when connected, were found to be approximately parallel

with the datum of sea-level, but showing variations amounting only to 13 feet in 20 miles. This upper water-table or hydraulic surface is at the summit of the Kalimnan strata (Lower Pliocene). The water seems to be almost invariably salt or brackish. What appears to have taken place is, that a limited amount of water percolated through the superficial beds until stopped by the impervious blue clays of the Kalimnan. Since there is no direct outlet to the sea for this upper water-bearing series, the salts are either concentrated in the water, or escape to the surface by capillarity and the action of the sun's rays, forming the various salt-pans and lakes; in the case of the calcium carbonate this forms the travertin of the Mallee.

(*b*) The full supply of fresh water was met with in each bore either at the top of the Janjukian or polyzoal rock series (Miocene beds), or very close to its upper limits. The impervious basement beds of this series may be either a Palæozoic rock or a band of chert of the Cainozoic series; or, in some cases, the carbonaceous clays of the lower part of the Janjukian.

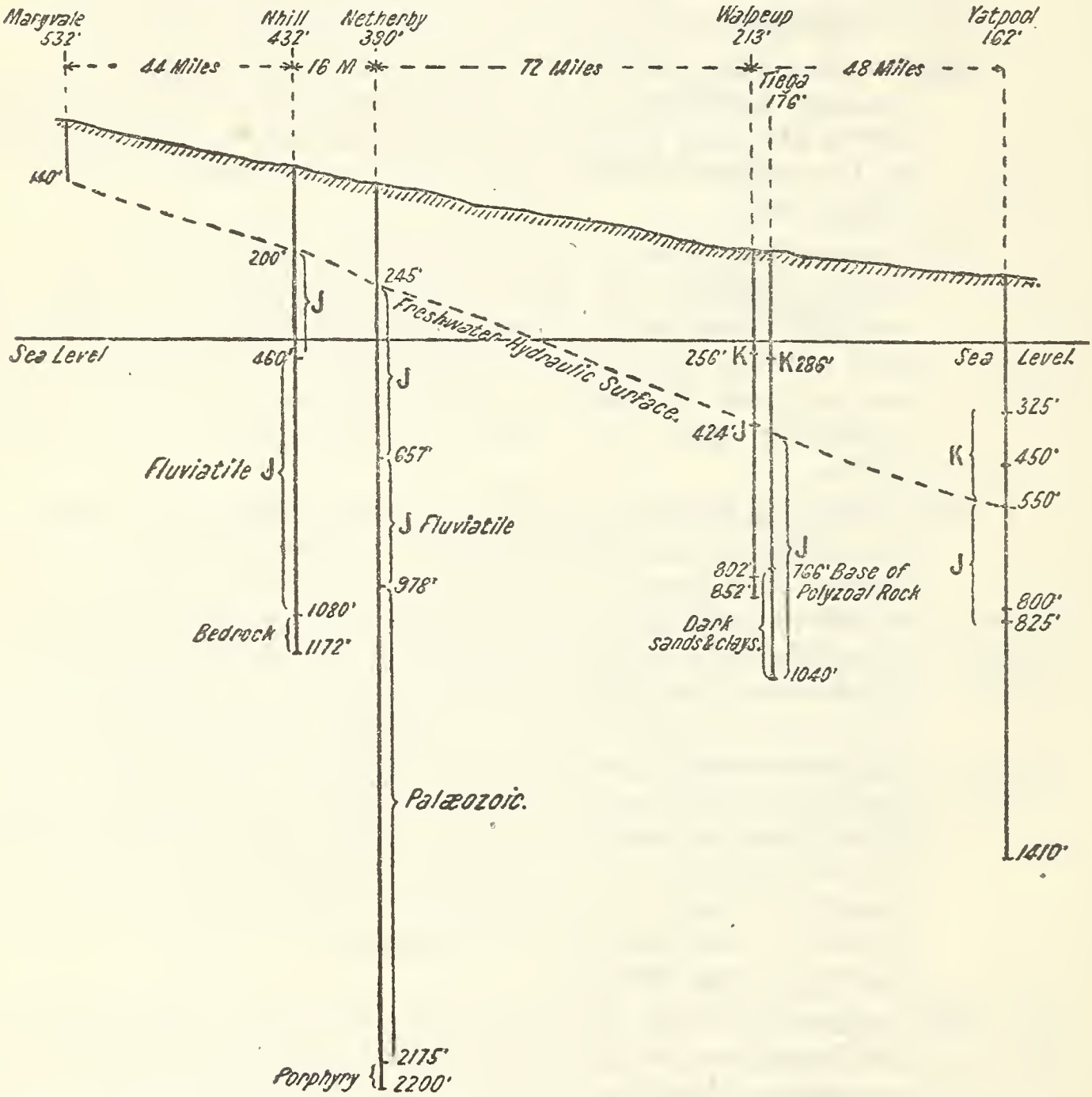


Fig. 42. Diagrammatic section showing the Janjukian (water-bearing) beds from Goroke to Yatpool. Bearing of line from Maryvale to Yatpool about N. 10° E.

Approx. Scale.—Horizontal, 48 miles to 1 in.; vertical, 630 ft. to 1 in.

(*c*) Going eastward this underground supply of fresh water is met with at the lower depths, in consequence of the thickening of the Cainozoic beds in this direction, due to a deepening of the basin.

(*d*) The thickening of this underlying older Tertiary series in an eastward direction is a factor in the greater permanency of the water supply in this area (Co. Weeah, &c.), since the older beds appear to be the main storage of the subartesian fresh-water supply of the Murray basin.

(*e*) In Bores 9 and 10 the strong flow of salt water is probably due to the existence of a submerged or infilled rift-valley which trends in a south-westerly direction to the Ninety Mile Desert in South Australia, as proved by the Tintinarra bore.

(*f*) From the foregoing data it may be inferred that the intake of the permanent supply of fresh water is at or near the margin of the basin, and in all probability the catchment area is largely situated on the outcrops of the older sedimentary (Palæozoic) rocks, as well as on the fissured and faulted surfaces of the igneous and metamorphic rocks, as the granites, diabases, quartz-porphyries and gneisses. It is here hypothecated that the percolating water of the Murray River basin finds its way down to the first impervious layer of any importance, the blue clay bed of the Kalimnan ; and the limited store is continually undergoing concentration, concomitantly with upward capillary flow of salt water into the superficial saline lakes. As already found by experience, this upper hydraulic layer requires to be closed in the bores by a casing, the boring to be effective having to be put down into the true water-bearing strata of the Janjukian polyzoal marls and limestones.

## 13. THE SUBDIVISIONS OF THE CAINOZOIC SERIES.

In lieu of the European divisions of the Cainozoic beds, which in earlier times it was not easy to determine as such in Australia, Professor Tate, and later, Drs. Hall and Pritchard, suggested local names for terrains which were fairly typical of particular sets of beds. In this place the names will be given in *alphabetical order*, but at the end of the note they will be referred to their corresponding places in the time-scale or column of strata (Fig. 43) illustrating the general aspect of the Cainozoic beds in the Mallee area.

Aldingan.[1]—This term was given to the Tertiary series shown in section at Aldinga Cliffs. The lower bed corresponds to Hall and Pritchard's Janjukian (Miocene of McCoy and Chapman) ; the upper series is correlated with the Kalimnan of Hall and Pritchard (Lower Pliocene of McCoy and Chapman).

Balcombian.[2]—Typified in the Balcombe Bay fossiliferous marls of the Mornington Peninsula (Hall and Pritchard). It corresponds with the lowest of the Tertiary series in southern Australia, according to the present author, but Hall and Pritchard place it above the Janjukian. Other exposures of these beds are :—The lower part of the Altona Bay coal shaft ; the lower part of the Sorrento bore ; and at Clifton Bank, Muddy Creek, Hamilton. This series is referred by McCoy and Chapman to the Oligocene of the northern hemisphere ; by Tate, Dennant, Hall and Pritchard to the Eocene. The Balcombian is not represented in the present bores since the marine transgression of that period did not extend so far inland.

Barwonian.[3]—An alternative term with Janjukian and Balcombian, suggested by Hall and Pritchard, to be employed where owing to palæontological similarity the relegation of the Lower Tertiary beds to either of the sets of strata mentioned, was doubtful. Typified in the series from Red Hill, Shelford, through Inverleigh, Murgheboluc, down the Barwon valley to Fyansford.

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[1] Trans. Roy. Soc., S. Aust. Vol. II., 1879, p. LIII.
[2] Proc. Roy. Soc., Vict., Vol. XIV. pt. II. (N.S.), 1902, pp. 78, 80.
[3] *Ibid.*, Vol. XVI., pt. II. (N.S.), 1904, p. 297.

| Age. | Strata in Mallee Bores. | Strata elsewhere. |
|---|---|---|
| Holocene .. | Loam and sand; layers of ironstone; concretions of carbonate of lime | Deposits now forming—dunes, beaches, lake deposits. |
| Pleistocene .. | Fine and coarse sands | Raised beaches; older swamp deposits with Diprotodon. |
| Werrikooian | Estuarine sands .. | Marine beds of Limestone Creek, Glenelg River; fossiliferous sands near Moorabool viaduct, near Geelong; estuarine sands in bores, South Australia. |
| Kalimnan .. | Stiff marls with shells and glauconite | Shelly sands, Beaumaris; shell-marls, Gippsland Lakes; upper shell-beds, Grange Burn, near Hamilton. |
| Janjukian .. | Polyzoal rock .. | Marine marls and polyzoal rock of Torquay; polyzoal rock of Batesford, Waurn Ponds and Flinders; middle limestone at Grange Burn; Lower and Middle Murravian; Lower Aldingan; limestone of King Island; marls of Corio Bay and Bairnsdale. |
| | Flints .. .. | |
| | Brown clays with lignite | Lower part probably equivalent to similar beds at Anglesea and the Aire Coast, Cape Otway district. |
| Bedrock .. .. .. .. | | |

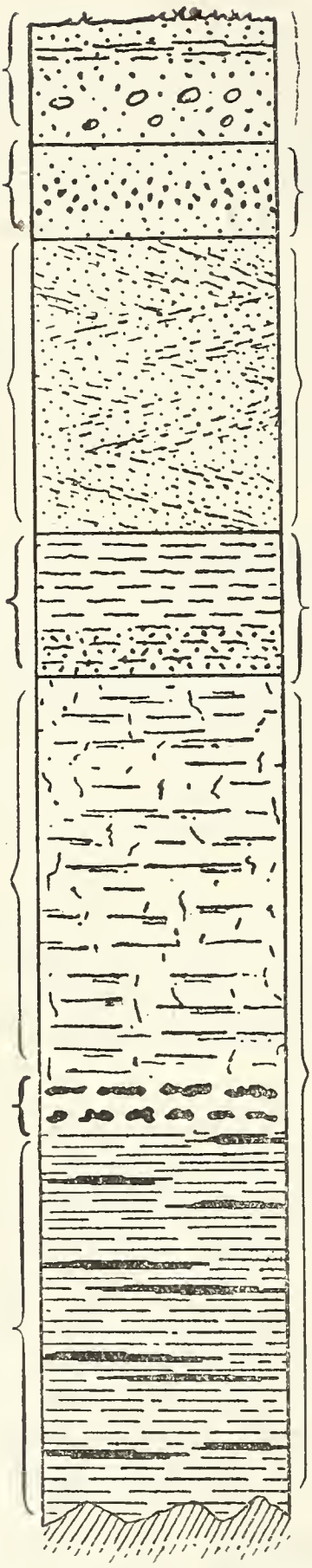

Fig. 43. Generalized section of the Mallee bores and the equivalent beds elsewhere.

Janjukian. [1]—Typified by the section at Torquay in the parish of Jan Juc. Referred to the Eocene by Hall and Pritchard; to the (?)Oligocene by Tate and Dennant; and to the Miocene by McCoy and Chapman. According to the present author the main development of marine strata of Tertiary age in Australia belongs to this continuous and gigantic phase of sedimentation. To this series belong the main water-bearing beds of the Mallee and Riverina artesian basin. Other well-known Janjukian beds are found at Grange Burn, Hamilton; at Waurn Ponds and Batesford, near Geelong; at Corio Bay; and at Bairnsdale. The great polyzoal series of South Australia is also of this age.

Kalimnan. [2]—This less important phase of sedimentation was named by Hall and Pritchard from its typical occurrence at Kalimna, in Gippsland. In the Mallee bores it forms a generally impervious stratum which seals down the lower freshwater supply, and stops the downward passage of the upper brackish waters. The Kalimnan can be referred to the Lower Pliocene (McCoy and Chapman), and is correlated with the Upper Aldingan beds and the upper or oyster beds of the Murray cliffs. Other localities for the Kalimnan series are Beaumaris and the upper beds at Grange Burn near Hamilton.

Murravian. [3]—A term given by Professor Tate to denote the Tertiary series of the Lower Murray cliffs. They undoubtedly fall into two series (upper, and middle and lower) of about the same ages as those at Aldinga, although of different faunal aspects, viz., Miocene and Lower Pliocene, or Janjukian and Kalimnan.

Werrikooian. [4]—This name was selected for the Upper Pliocene deposits of Limestone Creek, a tributary of the Glenelg River, in south-western Victoria. In the Mallee deposits, this series is represented by estuarine sands with brackish water and marine shells.

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[1] Proc. Roy. Soc., Vict., Vol. XIV., pt. II. (N.S.). pp. 78, 80.
[2] *Ibid.*, pp. 78, 80.
[3] Trans. Roy. Soc., S. Aust., Vol. II., 1879, p. LIII.
[4] Proc. Roy. Soc., Vict., tom. cit., pp. 78, 80.

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# DESCRIPTION OF PLATES.[1]

## Plate LXIII.

Fig. 1 *a*, *b*, *c*,—*Lithothamnion ramosissimum*, Reuss. Three examples of branchlets. Mallee bore No. 5, 163–175 feet. × 4.

2.—*L. ramosissimum*, Reuss. Vertical section of a branchlet, showing variable cell-dimensions. Mallee bore No. 3, 226 feet. × 26.

3.—*L. ramosissimum*, Reuss. Portion of same branchlet in section, showing two conceptacles with included tetraspores (T), the latter transforming into pale-green glauconite. × 52.

4.—*Trillina howchini*, Schlumberger. Lateral aspect of test Mallee bore No. 4, 163–170 feet. × 13.

5 *a*, *b*.—*Ammodiscus ovalis*, Chapm. : *a*, lateral aspect of test ; *b*, edge view. Mallee Bore No. 10, 160–186 feet. × 26.

6.—*Frondicularia lorifera*, sp. nov. Lateral aspect of test. Mallee bore No. 11, 438–440 feet. × 13.

7.—*Carpenteria proteiformis*, Goës. A young example, consisting of the rotaline basal series of chambers. Mallee bore No. 11, 540–542 feet. × 26.

8 *a*, *b*.—*Pulvinulina calabra*, Costa sp. : *a*, superior aspect ; *b*, inferior aspect. Mallee bore No. 5, 163–175 feet. × 13.

9.—*Polystomella striatopunctata*, F. and M. sp., var. *evoluta*, Chapm. Lateral aspect of test. Mallee bore No. 9, 263–273 feet. × 56.

## Plate LXIV.

Fig. 10.—*Holcotrochus crenulatus*, Dennant. Lateral aspect. Mallee bore No. 11, 197–199. × 26.

11 *a*, *b*.—*Mopsea tenisoni*, Chapm. : *a*, articular face of joint ; *b*, lateral surface of joint. Mallee bore No. 11, 555–560 feet. × 8.

12 *a*, *b*.—*M. tenisoni*, Chapm. : *a*, articular face of joint near distal end of corallum ; *b*, lateral aspect. Mallee bore No. 11, 544–546 feet. × 8.

13.—*M. tenisoni*, Chapm. Thin slice of a sector of a joint, magnified to show structure. Mallee bore No. 11, 495–500 feet. × 52.

14.—*Mopsea* cf. *encrinula*, Lam. sp. (Living). A thin slice of a sector of a joint of the corallum, to show similarity of structure with that of the preceding species. × 26.

15 *a–c*.—*Mopsea* sp., cf. *tenisoni*, Chapm : *a–c*, spicules or sclerodermites. Mallee bore No. 11, 546–548 feet. × 52.

16.—*M. hamiltoni*, Thomson sp. Articular face of joint. Mallee bore No. 11, 505–510 feet. × 8.

17 *a*, *b*.—*Isis compressa*, Duncan : *a*, lateral aspect ; *b*, articular face. Mallee bore No. 11, 495–500 feet. × 2.

18 *a*, *b*.—*Antedon protomacronema*, Chapm. : *a*, centro-dorsal seen from the side ; *b*, ventral aspect. Mallee bore No. 11, 430–432 feet. × 26.

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[1] The author is indebted to the Council of the Royal Society of Victoria, for permission to reproduce here the plates of Mallee fossils, and for the loan of the process blocks.

## Plate LXV.

Fig. 19.—*Antedon* sp. Cirrus joint. Mallee bore No. 11, 560–562 feet. × 26.

20.—*Pentagonaster* sp. Marginal plate. Mallee bore No. 11, 575–580 feet. × 4.

21.—*Pentagonaster* sp. Rounded plate of the abactinal area. Mallee bore No. 11, 575–580 feet. × 4.

22.—*Goniocidaris* sp. Hour-glass-shaped spine. Mallee bore No. 11, 530–535 feet. × 5.

23.—*Echinocyamus* (*Scutellina*) *patella*, Tate sp. Actinal surface showing marsupium. Mallee bore No. 11, 500–505 feet. × 2.

24 *a*, *b*.—*Serpula ouyenensis*, Chapm. : *a*, side view of large tube (spec. A) ; *b*, aperture. Mallee bore No. 11, 585–590 feet. × 4.

25.—*S. ouyenensis*, Chapm. A large tube (spec. B). Mallee bore No. 11, 585–599 feet. × 4.

26.—*Ditrupa cornea*, Linné sp., var. *wormbetiensis*, McCoy. Type of "*D. wormbetiensis*," McCoy. Cast from mould in ironstone near Stawell. × 2.

27.—*D. cornea*, L. sp., var. *wormbetiensis*, McCoy. Specimen showing annular nodosities. Mallee bore No. 5, 163–175 feet. × 2.

28.—*D. cornea*, L. sp., var. *wormbetiensis*, McCoy. Typical smooth specimen. Mallee bore No. 5, 163–175 feet. × 2.

29.—*D. cornea*, L. sp. var. *constricta*, Chapm. Irregularly constricted form. Mallee bore No. 5, 163–175 feet. × 2.

30.—*D. cornea*, L. sp., var. *constricta*, Chapm. Regularly constricted form. Mallee bore No. 5, 163–175 feet. × 2.

31.—*Spirorbis heliciformis*, Eichwald. Free or upper surface. Mallee bore No. 11, 564–566 feet. × 26.

32.—*Claviporella* sp. Zooecium. Mallee bore No. 5, 163–175 feet. × 52.

33.—*Selenaria marginata*, T. Woods, var. *spiralis*, Chapm. Inferior aspect of zoarium, showing spirally arranged zooecia. Mallee bore No. 9, 315–325 feet. × 16.

34.—*Terebratulina flindersi*, Chapm. : *a*, brachial valve ; *b*, pedicle valve ; *c*, lateral aspect. Mallee bore No. 11, 310–320 feet. × 4.

35.—*Terebratella acutirostra*, Chapm. : *a*, brachial valve ; *b*, pedicle valve ; *c*, lateral aspect. Mallee bore No. 11, 430–432 feet. × 8.

36.—*Terebratella portlandica*, Chapm. : *a*, brachial valve ; *b*, pedicle valve ; *c*, lateral aspect. Mallee bore No. 11, 525–530 feet. × 2.

37.—*T. portlandica*, Chapm. Interior of a brachial valve. Mallee bore No. 6, 154–156 feet. × i 2.

38.—*T. portlandica*, Chapm. Interor of a pedicle valve. Mallee bore No. 6, 114–150 feet. × 2.

## Plate LXVI.

Fig. 39.—*Mopsea tenisoni*, Chapm. Transverse section of sclero. basic axis, showing finely tegulate structure of the successive curved layers, and secondary radial arrangement-Mallee bore No. 11, 585–590 feet. × 14.

40.—*Mopsea* cf. *encrinula*, Lam. Transverse section showing coarsely tegulate structure. × 14.

41.—*Isis compressa*, Duncan. Transverse section of axis, showing highly ornate tegulate structure. Mallee bore No. 11, 495–500 feet. × 14.

42.—*Serpula ouyenensis*, Chapm. Transverse section of tube, showing laminated inner layer and tubulated outer layer. Mallee bore No. 11, 585–590 feet. × 36.

43.—*Lepralia gippslandii*, Waters. Mallee bore No. 5, 175–189 feet. × 7.

## Plate LXVII.

Fig. 1.—*Glycimeris maccoyi*, Johnston sp. Form *a*, with 32 riblets. Balcombian series. Grice's Creek, Port Phillip. Coll. W. Kershaw. Nat. size.

2.—*G. maccoyi*, Johnston sp. Form *b* (=*Pentunculus laticostatus*, McCoy, non Q. and G.), with about 40 riblets. Janjukian series. From McCoy's type locality, Bird Rock Cliffs, Torquay. Coll. J. F. Bailey. Nat. size.

3.—*G. maccoyi*, Johnston sp. Interior of valve showing finely striated area. Janjukian series. Bird Rock, Torquay. Geol. Surv. Vict. coll. Nat. size.

4.—*G. maccoyi*, Johnston sp. Specimen with 29 riblets. Janjukian series. Table Cape, Tasmania. Nat. size.

5.—*G. maccoyi*, Johnston sp. Form *c*, with 30 riblets. Kalimnan series. Macdonald's, Muddy Creek. Coll. F. Chapman. Nat. size.

## Plate LXVIII.

Fig. 6.—*Glycimeris laticostatus*, Quoy and Gaimard sp. Living. Coast of New Zealand. This species has about 40 riblets. Interior of valve to show the comparatively coarsely striate area. Nat. size.

7.—*Trigonia lamarcki*, Gray. Mallee bore No. 9. 315–325 feet. Nat. size.

8.—*T. lamarcki*, Gray. Living. Coast of New South Wales. For comparison with the above fossil. Nat. size.

9.—*T. lamarcki*, Gray. Costation of living specimen, magnified. × 7.

10.—*T. howitti*, McCoy. Costation magnified for comparison with the preceding figure. Cainozoic (Kalimnan series). Macdonald's, Muddy Creek. Dennant coll. × 7.

11.—*T. margaritacea*, Lamarck. Living example. Bass Strait. Nat. size.

## Plate LXIX.

Fig. 12.—*Trigonia margaritacea*, var. *acuticostata*, McCoy, Co-type of *T. acuticostata*, McCoy. Cainozoic (Kalimnan series). Beaumaris, Port Phillip. Nat. size.

13 *a*, *b*.—*T. margaritacea*, var. *acuticostata*, McCoy. Living example (2 valves). Bass Strait. Pres. by Capt. Stanley. Nat. size.

14.—*Euchelus baccatus*, Menke sp. Oral aspect. Mallee bore No. 5, 175–189 feet. Nat. size.

15 *a*, *b*.—*Natica subinfundibulum*, var. *crassa*, Tate. *a*, dorsal aspect; *b*, oral aspect. Mallee bore No. 10, 220 feet. Nat. size.

## Plate LXX.

Fig. 16.—*Arcoperna scapha*, Verco. Mallee bore No. 3, 226 feet. × 4.

17 *a–c*.—*Condylocardia tenuicostae*, Chapm. and Gabr.: *a*, exterior of left valve, × 13; *b*, cardinal area of left valve, × 26; *c*, cardinal area of right valve, × 26; *a* and *b*, holotype. Mallee bore No. 10, 310–320 feet; *c*, Mallee bore No. 10, 225–30 feet.

18.—*Cardita calva*, Tate. An extreme variety with costation suppressed and concentrics dominant. Mallee bore No. 9, 254–256 feet. × 6.

19 *a*, *b*.—*Donax kenyoniana*, Chapm. and Gabr. Holotype: *a*, right valve, × 2; *b*, portion of the same to show colour bands and radial striate, × 4. Mallee bore No. 10, 310–320 feet.

20.—*D. kenyoniana*, Chapm. and Gabr. Paratype. Interior of left valve. Mallee bore No. 8, 160–165 feet. Nat. size.

21.—*D. kenyoniana*, Chapm. and Gabr. Paratype. Ventral edge of valve interior. Mallee bore No. 10, 186–190 feet. × 8.

22.—*Liotia dennanti*, Chapm. and Gabr. Holotype. Oral aspect, Mallee bore No. 8, 180–199 feet. × 4.

23.—*L. dennanti*, Chapm. and Gabr. Paratype. Portion of shell more highly magnified to show intercostal, thread-like ornament. Cainozoic (Balcombian series). Lower beds, Muddy Creek. Ex. Dennant coll. × 8.

24 *a*, *b*.—*Teinostoma depressula*, Chapm. and Gabr. Holotype: *a*, apical aspect; *b*, umbilical aspect. Mallee bore No. 10, 225–230 feet. × 8.

25 *a–c*.—*Teinostoma pulcherrima*, Chapm. and Gabr. Holotype: *a*, apical aspect, × 4; *b*, umbilical aspect, × 4; *c*, surface ornament, × 12. Mallee bore No. 10, 225–230 feet.

26.—*Eulima pinguicula*, Chapm. and Gabr. Holotype. Mallee bore No. 10, 225–230 feet. × 8.

## Plate LXXI.

Fig. 27 *a*, *b*.—*Turbonilla weeahensis*, Chapm. and Gabr. Holotype: *a*, oral aspect, × 4; *b*, protoconch, × 26. Mallee bore No. 10, 225–230 feet.

28 *a–c*.—*Calyptraea kalimnae*, Chapm. and Gabr. Holotype: *a*, apical aspect; *b*, lateral aspect; *c*, umbilical aspect. Cainozoic (Kalimnan series). Gippsland Lakes (ex. Dennant coll.). × 2.

29.—*C. kalimnae*, Chapm. and Gabr. Paratype. One of the typically small forms from the Mallee bores (No. 8, 165–180 feet). × 2.

30.—*Rissoa gatliffiana*, Chapm. and Gabr. Holotype. Mallee bore No. 10, 225–235 feet. × 20.

31.—*Rissoa* (*Onoba*) *bassiana*, Hedley. Mallee bore No. 8, 180–199 feet. × 8.

32.—*Rissoa* (*Onoba*) *chrysalida*, Chapm. and Gabr. Holotype. Typical form. Mallee bore No. 9, 254–256 feet. × 8.

33.—*Rissoa* (*O.*) *chrysalida*, Chapm. and Gabr. Paratype. Extreme, elongate form. Cainozoic (Kalimnan series). Upper beds, Murray Creek. Ex. Dennant coll. × 8.

34.—*Nassa spiraliscabra*, Chapm. and Gabr. Holotype. Mallee bore No. 8, 199–204 feet. × 4.

35.—*Marginella praeformicula*, Chapm. and Gabr. Holotype. Mallee bore No. 8, 180–199 feet. × 4.

36.—*Terebra profunda*, Chapm. and Gabr. Holotype. Mallee bore No. 10, 225–230 feet. × 4.

37.—*Pleurotoma* (*Drillia*) *dilectoides*, Chapm. and Gabr. Holotype. Cainozoic (Kalimnan series). Gippsland Lakes. Ex. Dennant coll. × 4.

## Plate LXXII.

Fig. 1.—*Argilloecia badia*, G. S. Brady. Right valve. Mallee bore No. 5, 189–190 feet. × 52.

2.—*Marocypris decora*, G. S. Brady sp. Right valve; specimen showing original colour markings. Mallee bore No. 9, 256–263 feet. × 52.

3.—*Macrocypris tumida*, G. S. Brady. Right valve. Mallee Bore No. 10, 310–320 feet. × 52.

4.—*Bythocypris tumefacta*, Chapm. *a*, Carapace seen from the right side; *b*, seen from below; *c*, end view. Mallee bore No. 11, 542–544 feet. × 40.

5.—*B. tumefacta*, Chapm. Another specimen (paratype), left valve. Mallee bore No. 10, 310–320 feet. × 40.

6.—*Bairdia amygdaloides*, G. S. Brady. Left valve. Mallee bore No. 10, 310–320 feet. × 52.

7.—*Bairdia australis*, Chapm. Right valve. Mallee bore No. 9, 256–263 feet. × 52.

8.—*Cythere canaliculata*, Reuss sp. Right valve. Mallee bore No. 11, 219–260 feet. × 52.

9.—*Cythere crispata*, G. S. Brady. Right valve. Mallee bore No. 11, 554–556 feet. × 52.

10.—*Cythere dasyderma*, G. S. Brady. Left valve. Mallee bore No. 11, 554–556 feet. × 52.

11.—*Cythere demissa*, G. S. Brady. Left valve. Mallee bore No 10, 160–186 feet. × 52.

## Plate LXXIII.

Fig. 12.—*Cythere dictyon*, G. S. Brady. Left valve of a youthful form, and well preserved. Mallee bore No. 9, 315–325 feet. × 40.

13.—*C. dictyon*, G.S.B. Right valve of senile form, with smoother and thicker carapace. Mallee bore No. 11, 438–440 feet. × 40.

14.—*Cythere flexicostata*, Chapm. *a*, right valve; *b*, profile of valve seen from above. Mallee bore No. 10, 310–320 feet. × 52.

15.—*Cythere lactea*.—G. S. Brady. Right valve. Mallee bore No. 11, 562–564 feet. × 40.

16.—*Cythere lepralioides*, G. S. Brady. Right valve. Mallee bore No. 8, 210–219 feet. × 52.

17.—*Cythere lubbockiana*, G. S. Brady. Right valve. Mallee bore No. 11, 260–265 feet. × 52.

18.—*Cythere militaris*, G. S. Brady sp. Right valve. Mallee bore No. 9, 256–263 feet. × 52.

19.—*Cythere normani*, G. S. Brady. Right valve. Mallee bore No. 10, 310–320 feet. × 40.

20.—*Cythere obtusalata*, G. S. Brady. Right valve. Mallee bore No. 9, 256–263 feet. × 52.

21.—*Cythere ovalis*, G. S. Brady. Left valve. Mallee bore No. 11, 276–270 feet. × 40.

22.—*Cythere parallelogramma*, G. S. Brady. Left valve. Mallee bore No. 9, 315–325 feet. × 52.

23.—*Cythere postdeclivis*, Chapm. *a*, left valve; *b*, profile of valve. Mallee bore No. 10, 310–320 feet. × 40.

24.—*Cythere rastromarginata*, G. S. Brady. Right valve. Mallee bore No. 11, 170–175 feet. × 52.

## Plate LXXIV.

Fig. 25.—*Cythere scabrocuneata*, G.S. Brady. Right valve of a quadrate variety. Mallee bore No. 11, 457–458 feet. × 40.

26.—*Cythere scintillulata*, G. S. Brady. Left valve. Mallee bore No. 5, 189–190 feet. × 52.

27.—*Cythere scutigera*, G. S. Brady. Left valve. Mallee bore No. 5, 189–190 feet. × 40.

28.—*Cythere wyville-thomsoni*, G. S. Brady. Left valve. Mallee bore No. 10, 310–320 feet. × 40.

29.—*Krithe eggeri*, sp. nov. *a*, left valve; *b*, profile, from below. Mallee bore No. 11, 260–265 feet. × 52.

30.—*Lexoconcha australis*, G. S. Brady. Left valve. Mallee bore No. 10, 225–230 feet. × 52.

31.—*Xestoleberis curta*, G. S. Brady sp. Right valve. Mallee bore No. 10, 225–230 feet. × 52.

32.—*Xestoleberis margaritea*, G. S. Brady. Left valve. Mallee bore No. 11, 267–270 feet. × 52.

33.—*Xestoleberis variegata*, G. S. Brady. Left valve. Mallee bore No. 11, 267–270 feet. × 52.

34.—*Cytherura capillifera*, Chapm. *a*, right valve; *b*, profile. Mallee bore No. 11, 175–197 feet. × 52.

35.—*Cytherura ouyenensis*, Chapm. *a*, right valve; *b*, profile seen from above. Mallee bore No. 11, 267–270 feet. × 52.

36.—*Cytheropteron batesfordiense*, Chapm. Right valve. Mallee bore No. 11, 440–442 feet. × 40.

37.—*C. batesf rdiense*, var. *aculeata*, Chapm. Left valve. Mallee bore No. 11, 453–454 feet. × 40.

38.—*Cytheropteron postumbonatum*, Chapm. *a*, right valve; *b*, profile seen from below. Mallee bore No. 8, 210–218 feet. × 52.

## Plate LXXV.

39.—*Cytheropteron praeantarcticum*, Chapm. *a*, left valve ; *b*, valve seen from above. Mallee bore No. 9, 256–263 feet. × 52.

40.—*Cytheropteron reticosum*, Chapm. *a*, left valve ; *b*, profile. Mallee bore No. 10, 195–225 feet. × 52.

41.—*Cytheropteron rostratum*, Chapm. *a*, carapace seen from left side ; *b*, profile from below. Mallee bore No. 11, 175–197 feet. × 52.

42.—*Cytherella auriculus*, Chapm. *a*, left valve ; *b*, profile. Mallee bore No. 11, 210–260 feet. × 52.

43.—*C. auriculus*, Chapm. Left valve of a young example. Mallee bore No. 11, 219–260 feet. × 52. (Not numbered on plate).

44.—*Cytherella lata*, G. S. Brady. *a*, left valve ; *b*, profile. Mallee bore No. 5, 163–175 feet. × 52.

45.—*Cytherella polita*, G. S. Brady. *a*, left valve ; *b*, profile. Mallee bore No. 9, 315–325 feet. × 52.

46.—*Cytherella pulchra*, G. S. Brady. *a*, right valve ; *b*, profile. Mallee bore No. 10, 230–254 feet. × 52.

47.—*Cytherella punctata*, G. S. Brady. Left valve. Mallee bore No. 9, 256–263 feet. × 52.

48.—*Cytherella subtruncata*, Chapm. *a*, carapace seen from the left side ; *b*, carapace seen from below. Mallee bore No. 10, 225–230 feet. × 52.

## Plate LXXVI.

Fig. 49.—*Scalpellum subquadratum*, Chapm. *a*, carina, dorsal view ; *b*, lateral view ; *c*, interior of valve ; *d*, section across posterior end of valve (holotype). Mallee bore No. 4, 163–170 feet. × 2.

50.—*S. subquadratum*, Chapm. (?) Rostral latus (paratype). Mallee bore No. 10, 310–320 feet. × 2.

51.—*S. subquadratum*, Chapm. Scutum : *a*, exterior ; *b*, interior of valve (paratype). Mallee bore No. 4. 163–170 feet. × 2.

52.—*Balanus psittacus*, Molina sp. Rostral compartment : *a*, exterior ; *b*, interior, showing strongly denticulated septa of the radii. Mallee bore No. 9, 315–325 feet. × 2.

53.—*Balanus varians*, G. S. Sowerby. A complete base. Mallee bore No. 9, 315–325 feet. × 2.

54.—*B. varians*, Sowerby. A carinal valve. Mallee bore No. 9, 315–325 feet. × 2.

55.—*Cestracion cainozoicus*, Chapman and Pritchard. Anterior lateral tooth. Mallee bore No. 8, 210–219 feet. × 4.

56.—*Trygon* cf. *rugosus*, Probst sp. *a*, anterior aspect of tooth ; *b*, posterior aspect ; *c*, side view ; *d*, upper surface of tooth. Mallee bore No. 5, 163–175 feet. × 4.

57.—*Myliobatis moorabbinensis*, Chapman and Pritchard. Lower or articulated surface of tooth. Mallee bore No. 10, 225–230 feet. × 2.

58.—(?) *Chrysophrys* sp. Rounded pavement tooth ; with crenulated basal margin. Mallee bore No. 8, 210–219 feet. × 5.

59.—(?) *Chrysophrys* sp. Tooth with thickened basal margin. Mallee bore No. 3, 201–220 feet. × 4.

## Plate LXXVII.

Fig. 1.—Photomicrograph of concretionary limestone. Mallee bore No. 7, 4–8 feet. (Holocene.) × 14.

2.—Photomicrograph of consolidated dune sand (Weerikooian or Pleistocene). Mallee bore No. 5, 104–114 feet. × 32.

## Plate LXXVIII.

Fig. 1.—Photomicrograph of glauconitic limestone with numerous foraminifera, echinoid spines and worm-tube (Ditrupa). Janjukian age Mallee bore No. 2, 200–206 feet. × 52.

2. Photomicrograph of organic cherty rock with Orbitolites. Probably near the top of the Janjukian series. Mallee bore No. 1, 210–212 feet. × 14.

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PLATE LXIII.

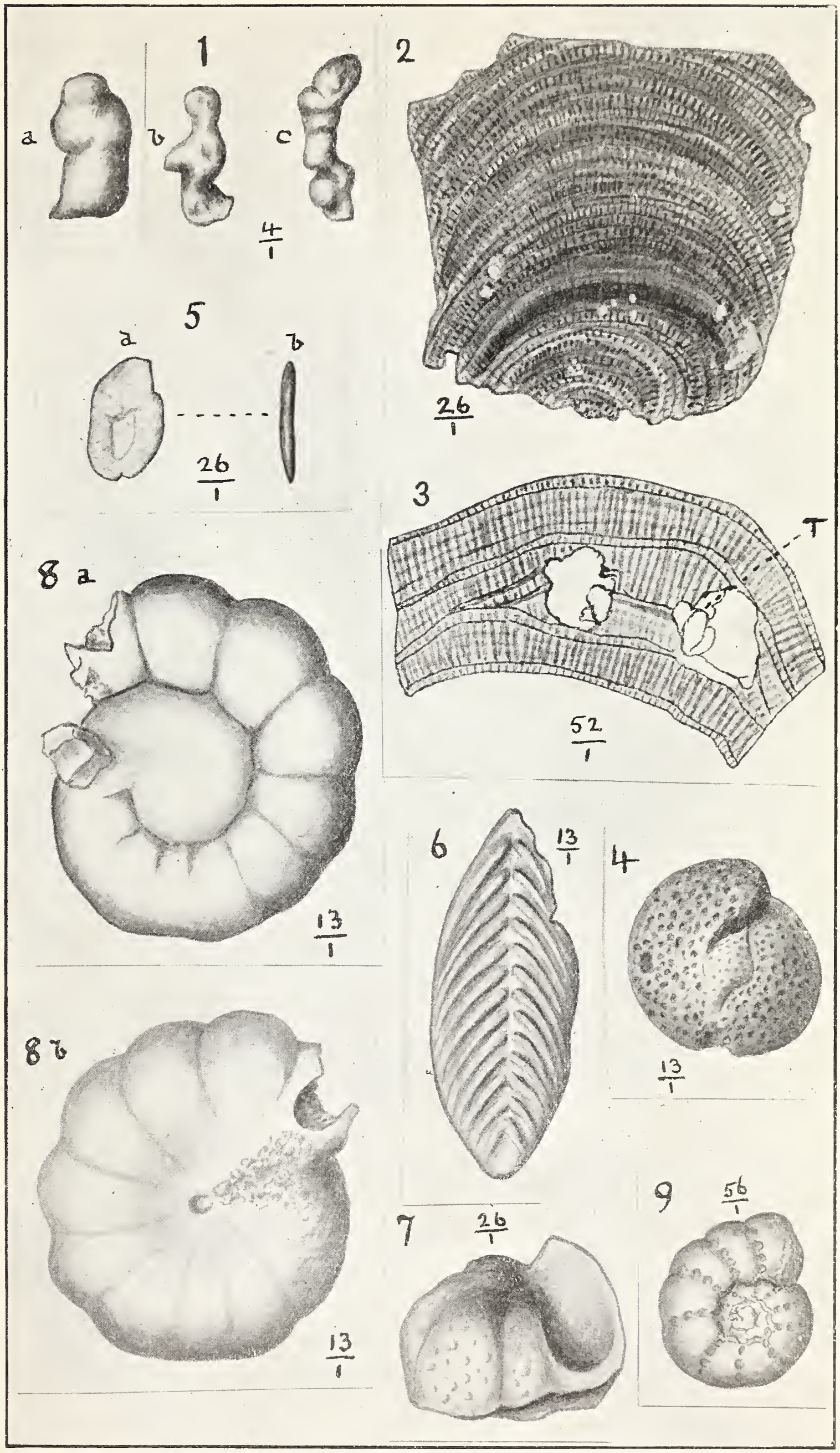


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PLATE LXIV.

10

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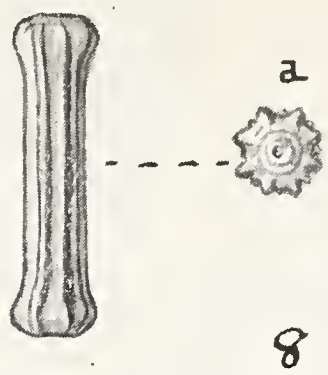
12

b

a



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1b

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11a

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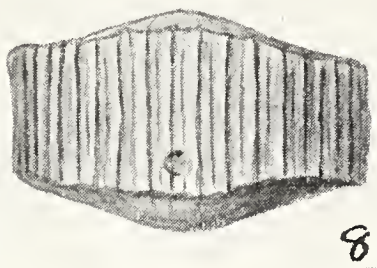
11b



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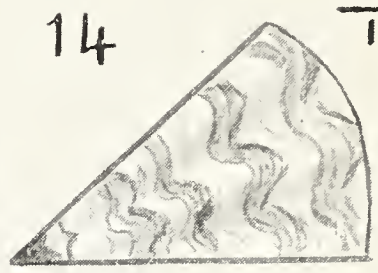

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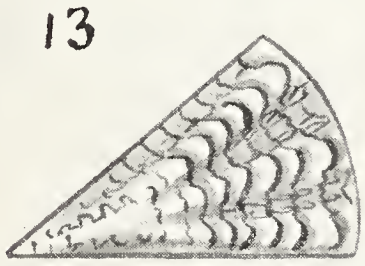

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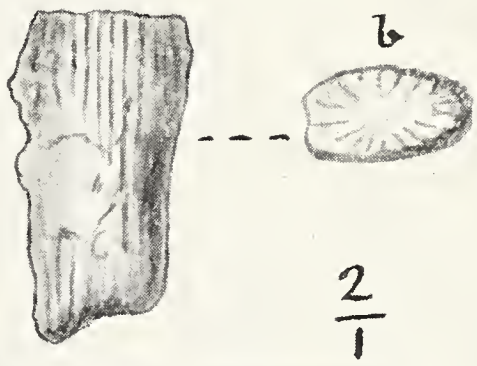
17

a

b



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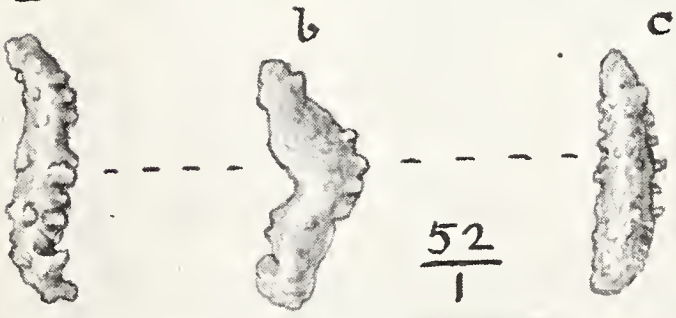
15

a

b

c



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18 a

26/1

18 b

26/1

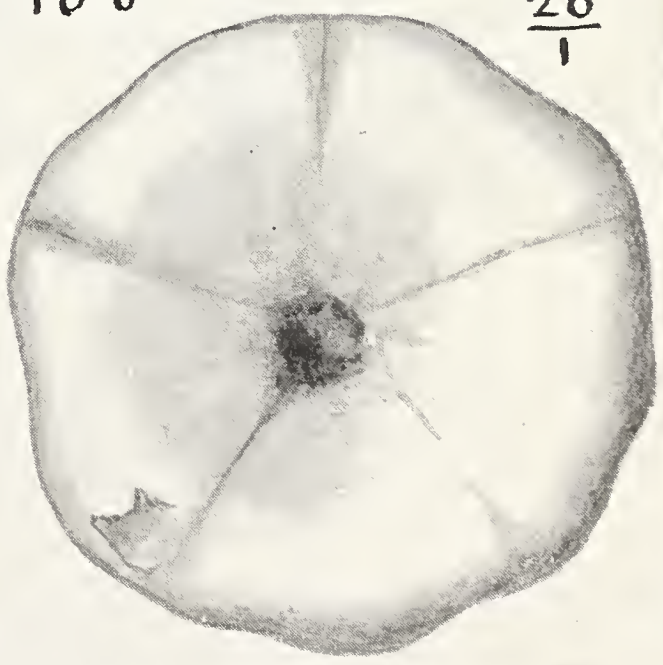

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PLATE LXV.

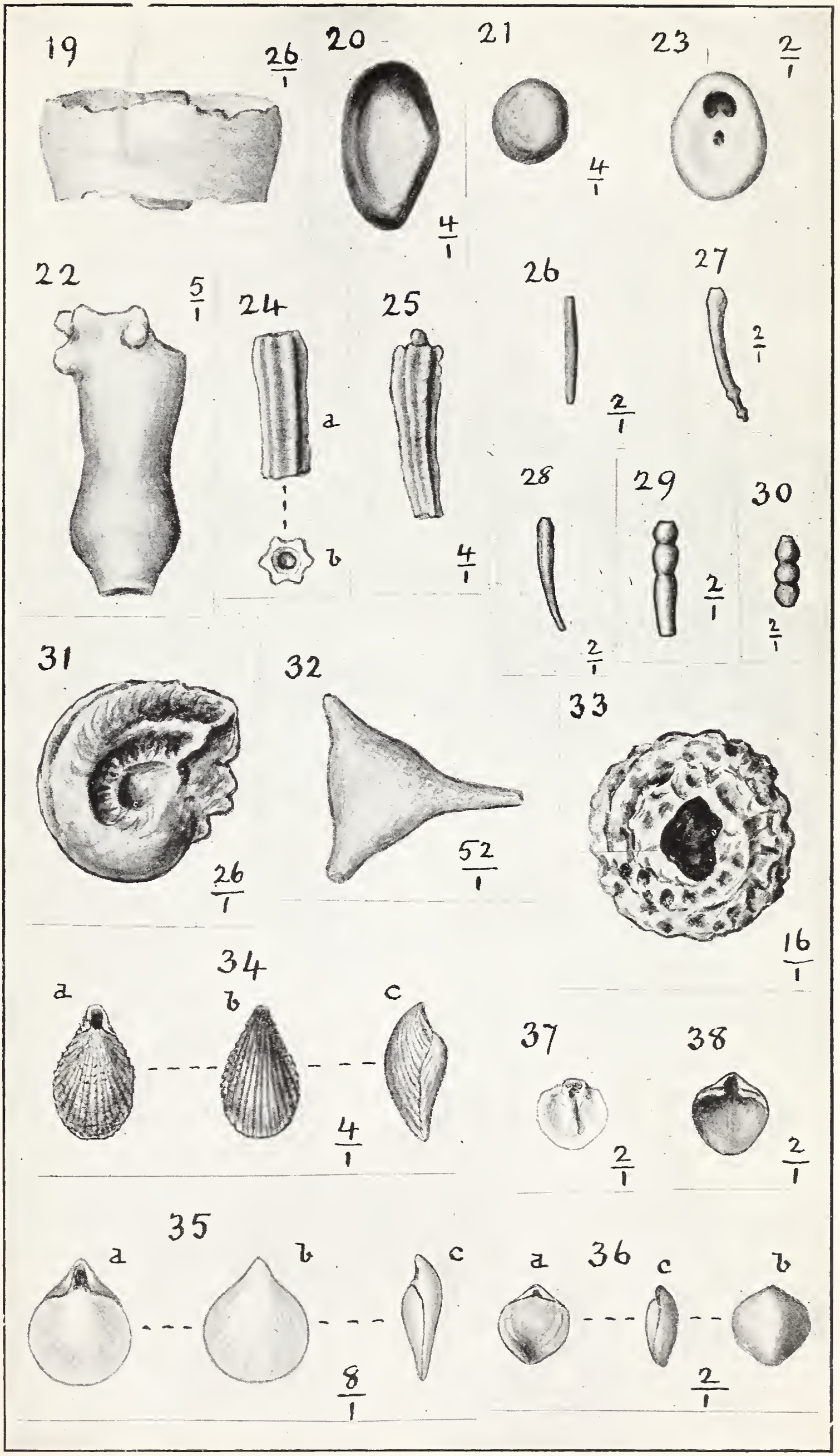


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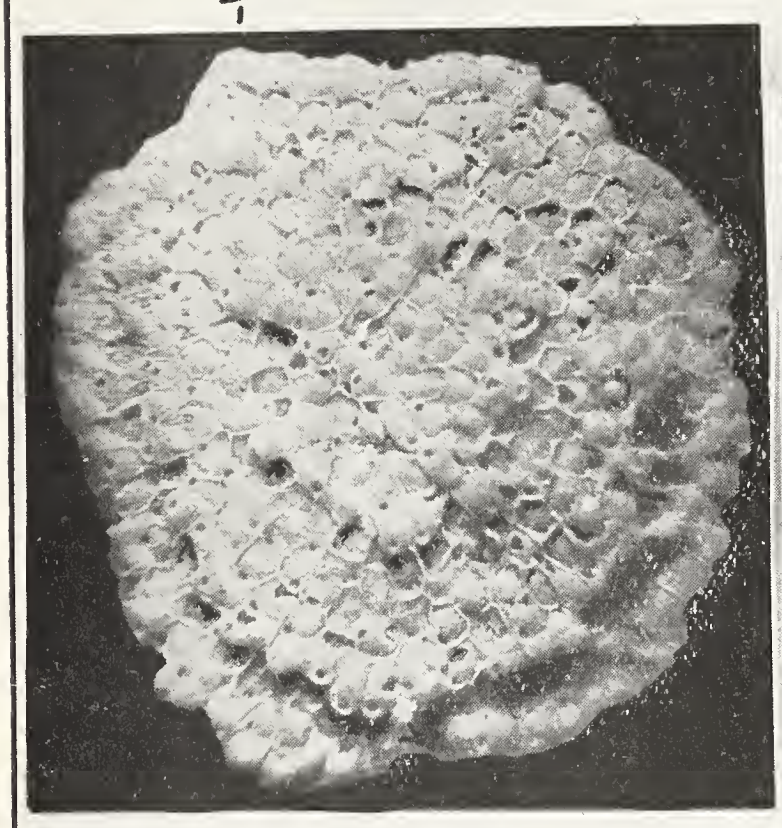
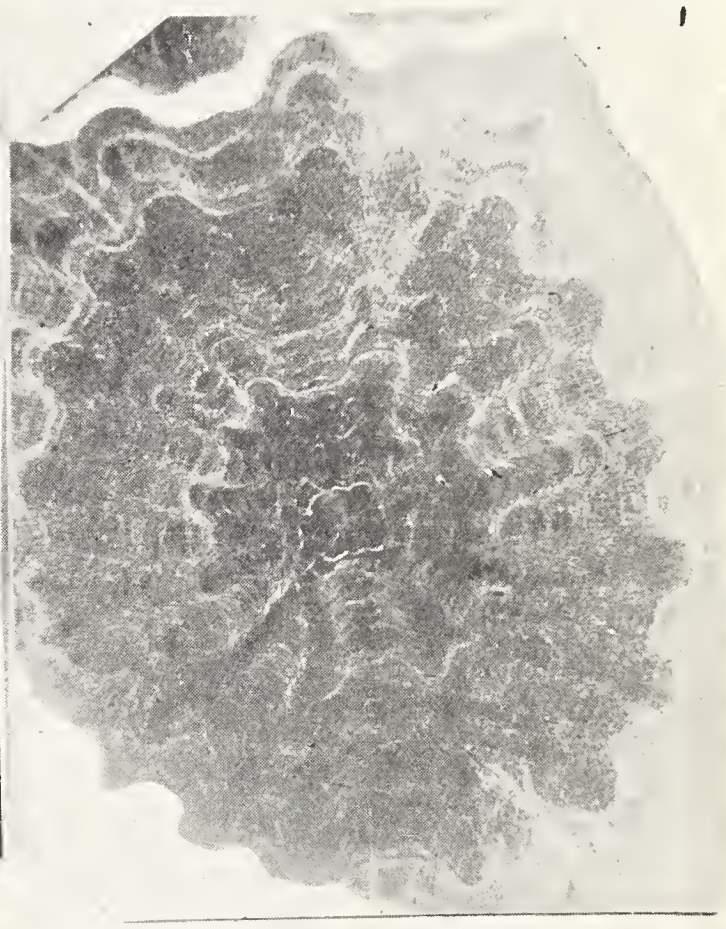
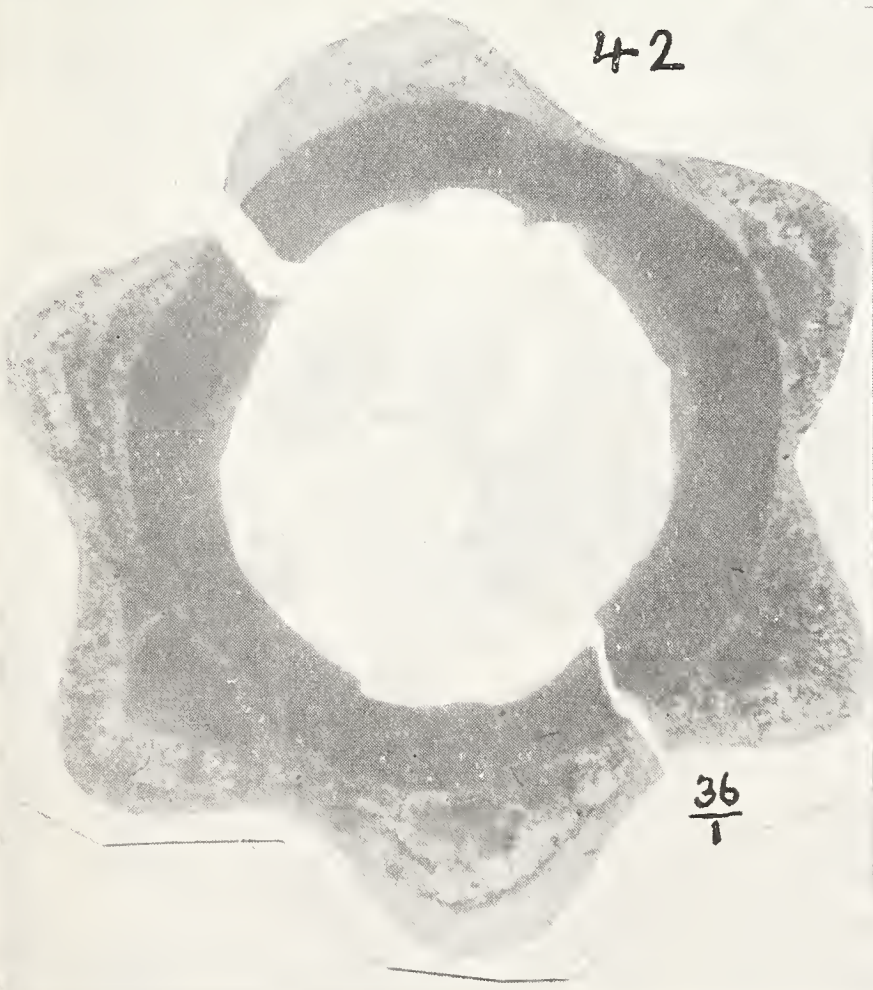
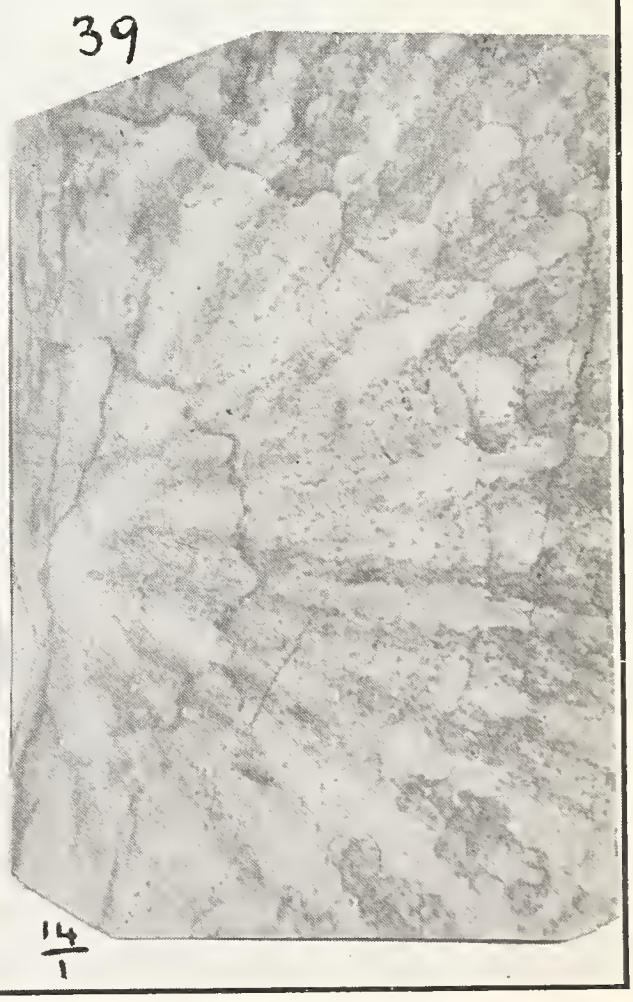
PLATE LXVI.




F.C., Photo.

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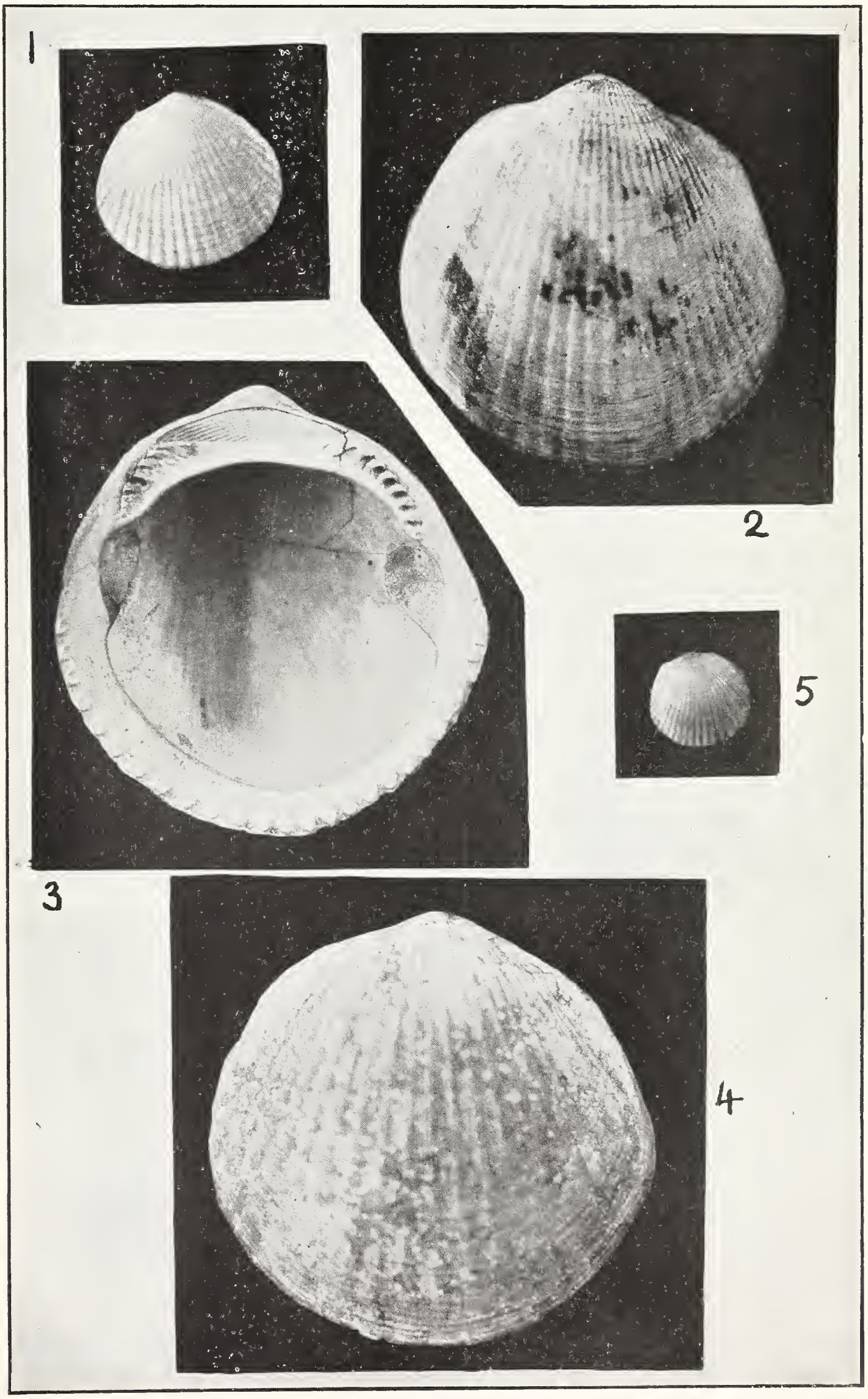
## Plate LXVII.




F.C., Photo.

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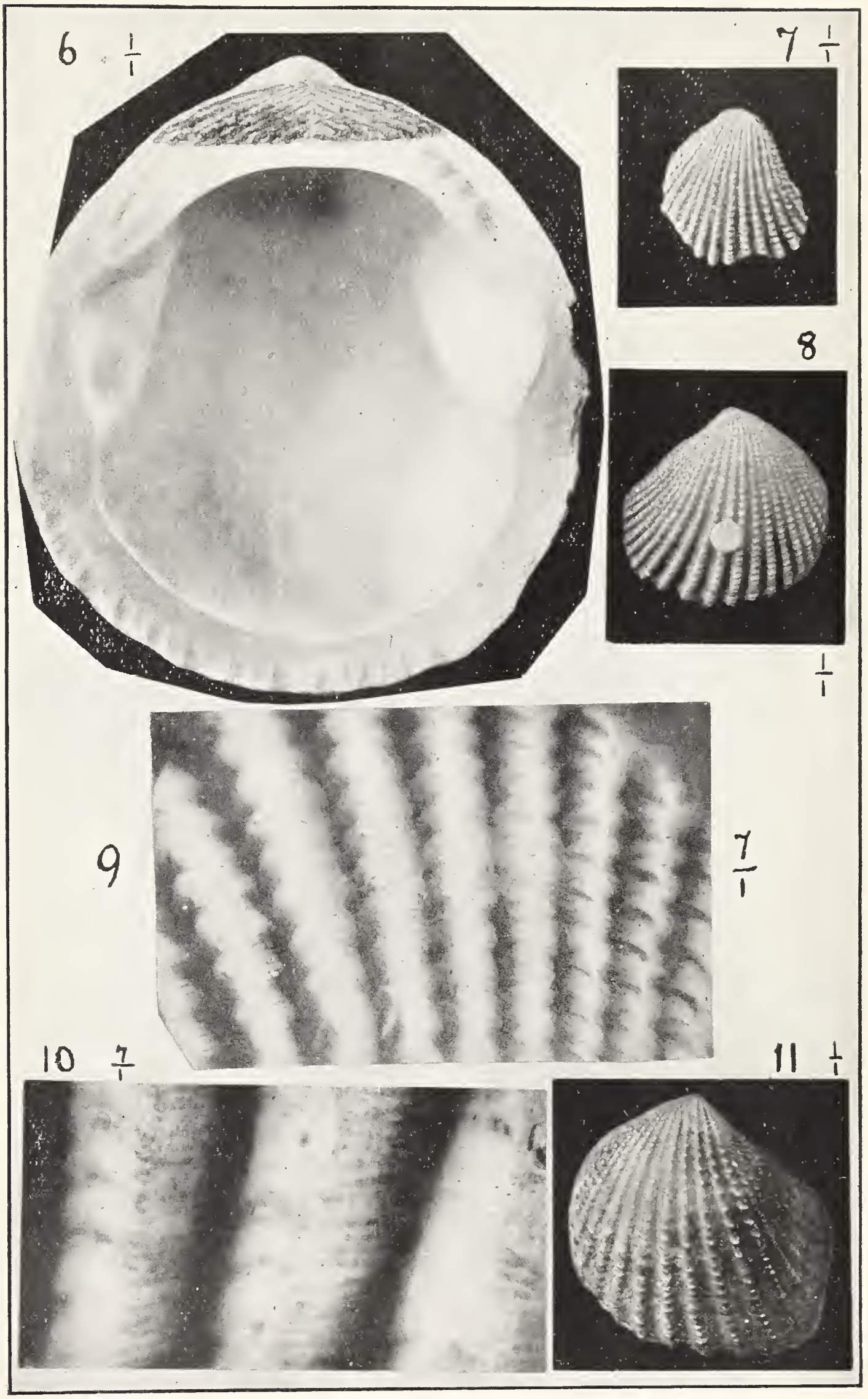
## Plate LXVIII.




F.C., Photo.

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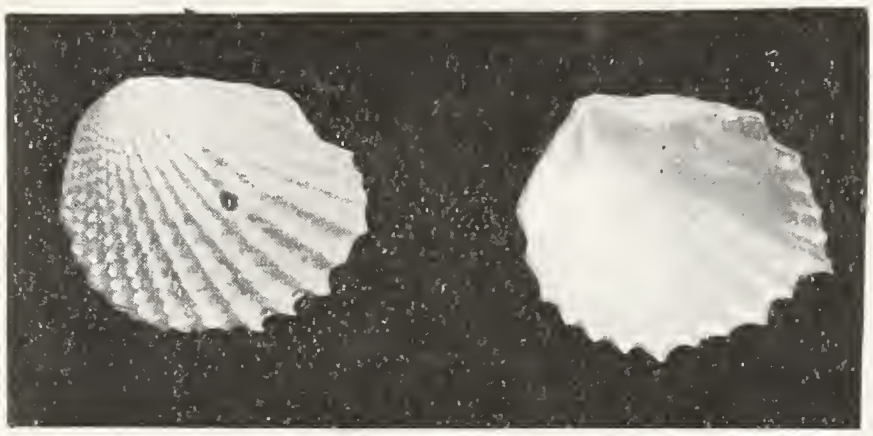
PLATE LXIX.

13



14

15 a.

15 b.

12

F.C., Photo.

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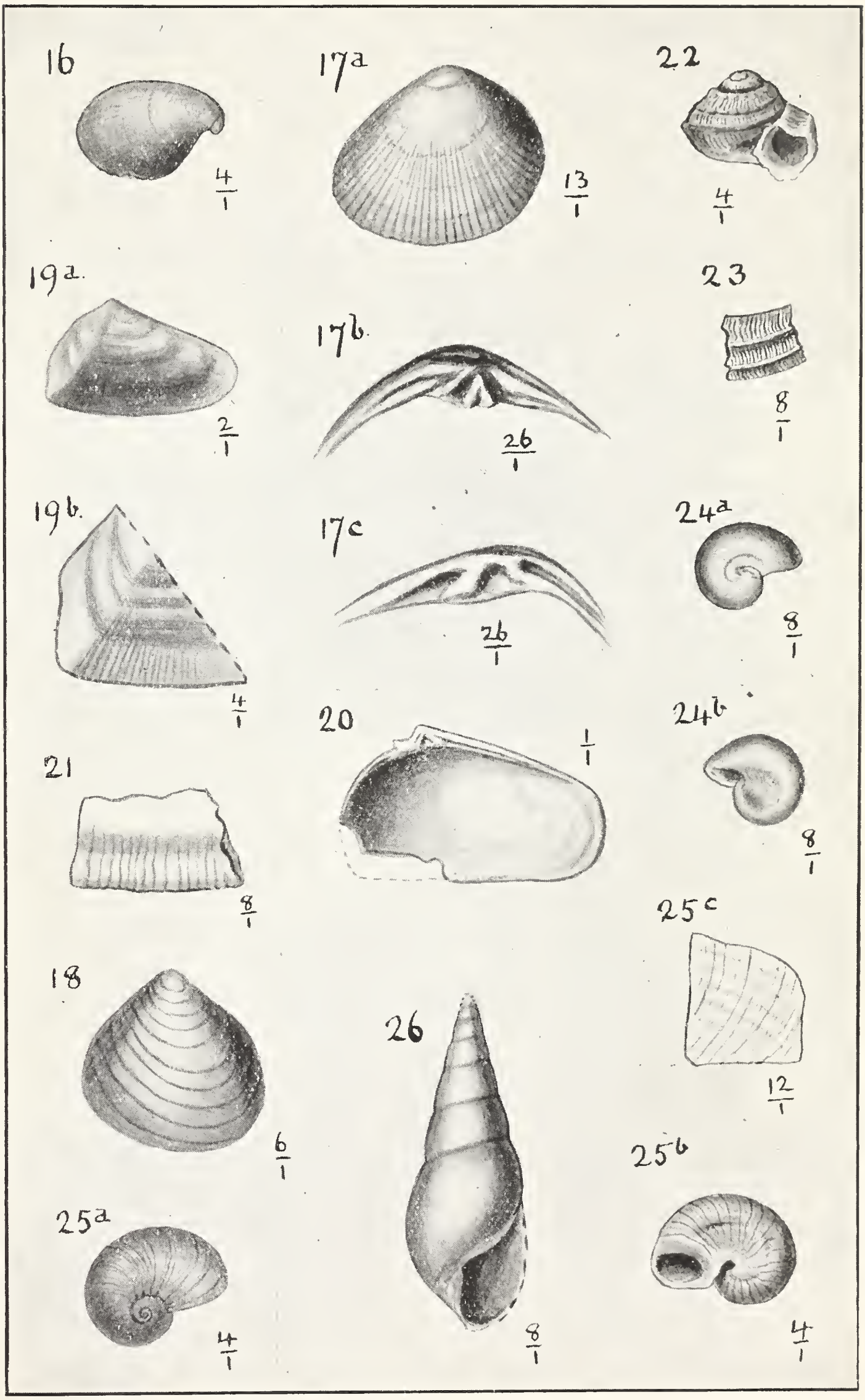
PLATE LXX.




F.C., ad nat. del.

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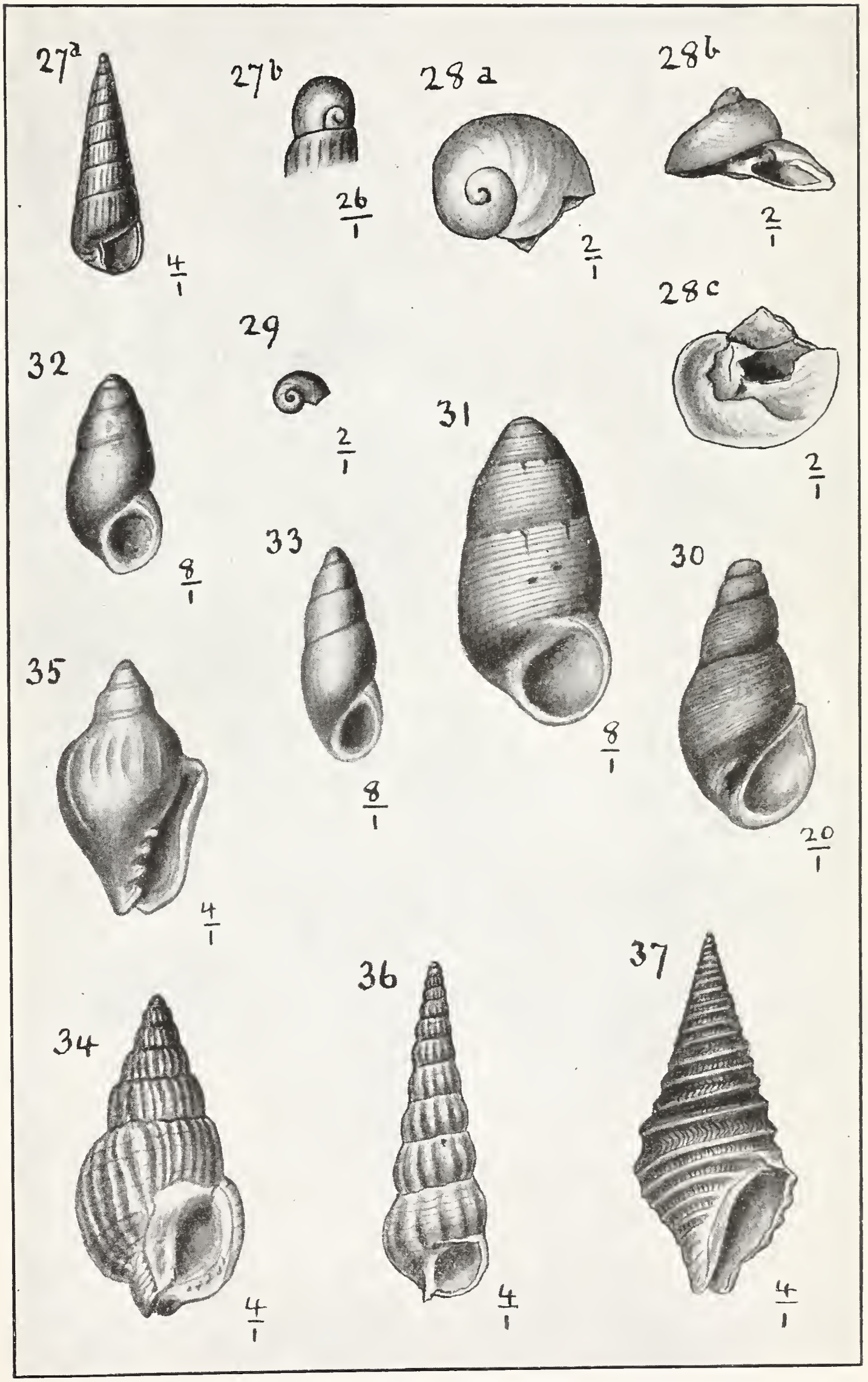
PLATE LXXI.




F.C., ad nat. del.

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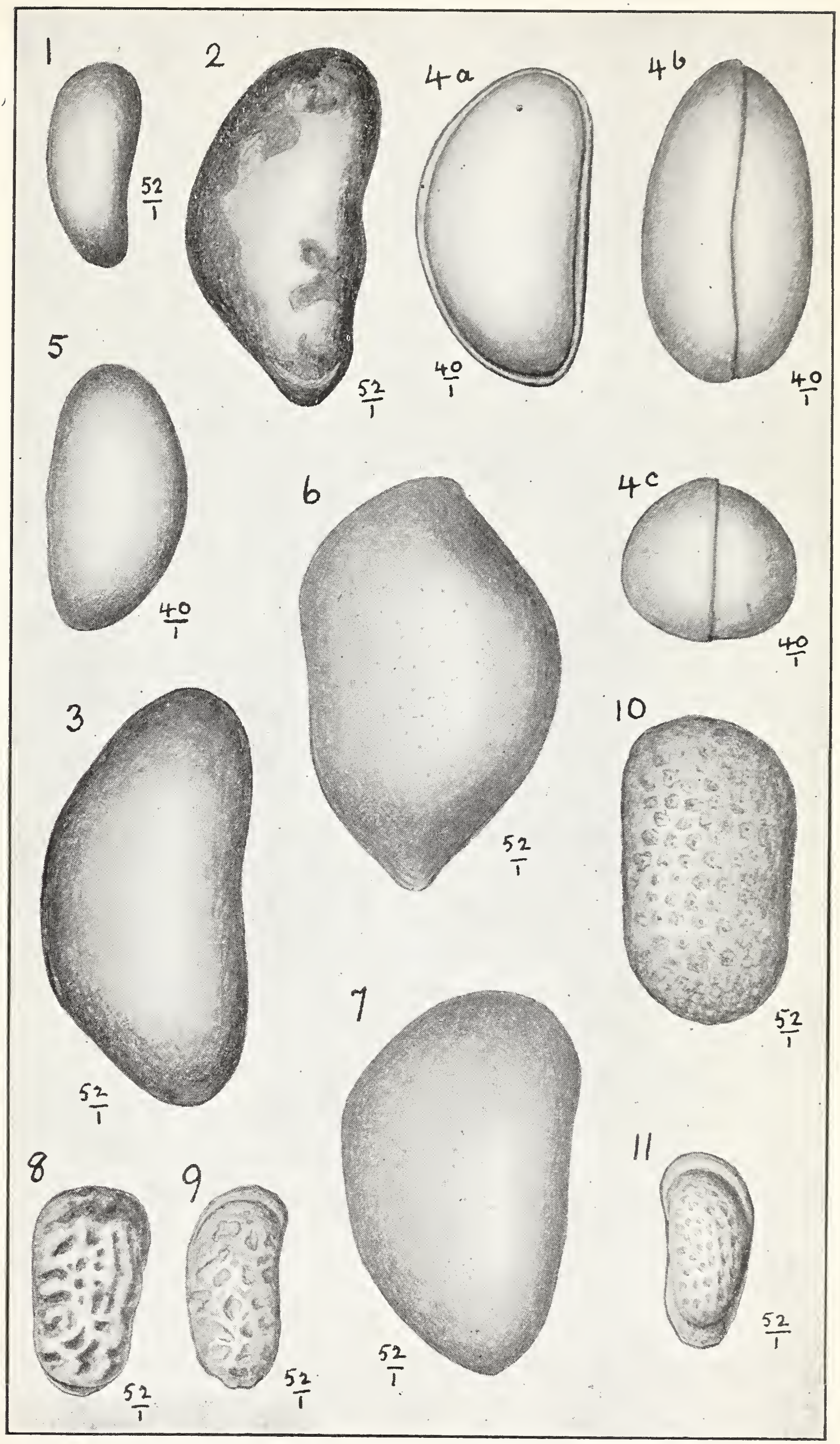
## Plate LXXII.




F.C., ad nat. del.

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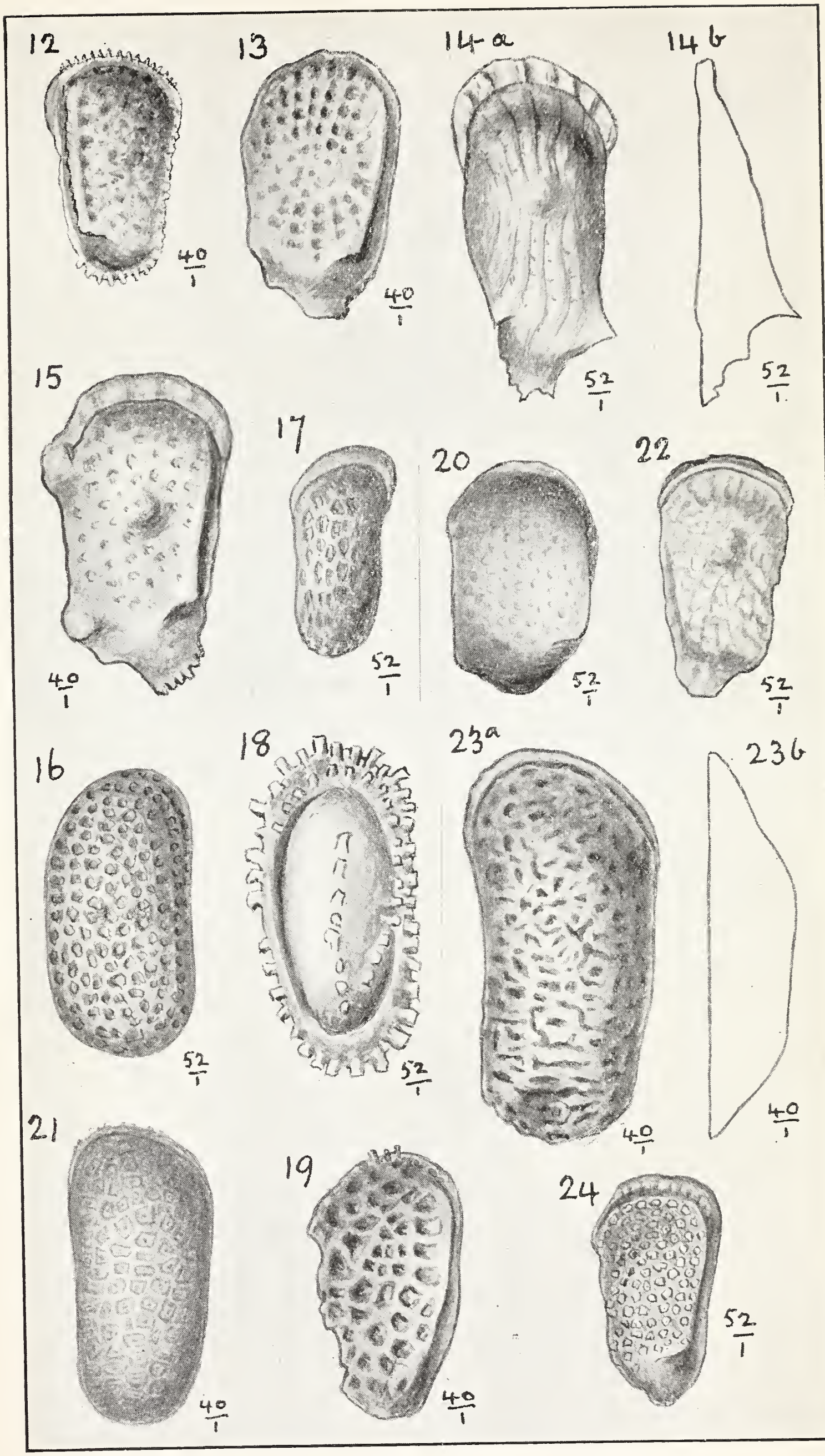
PLATE LXXIII.




F.C., ad nat. del.

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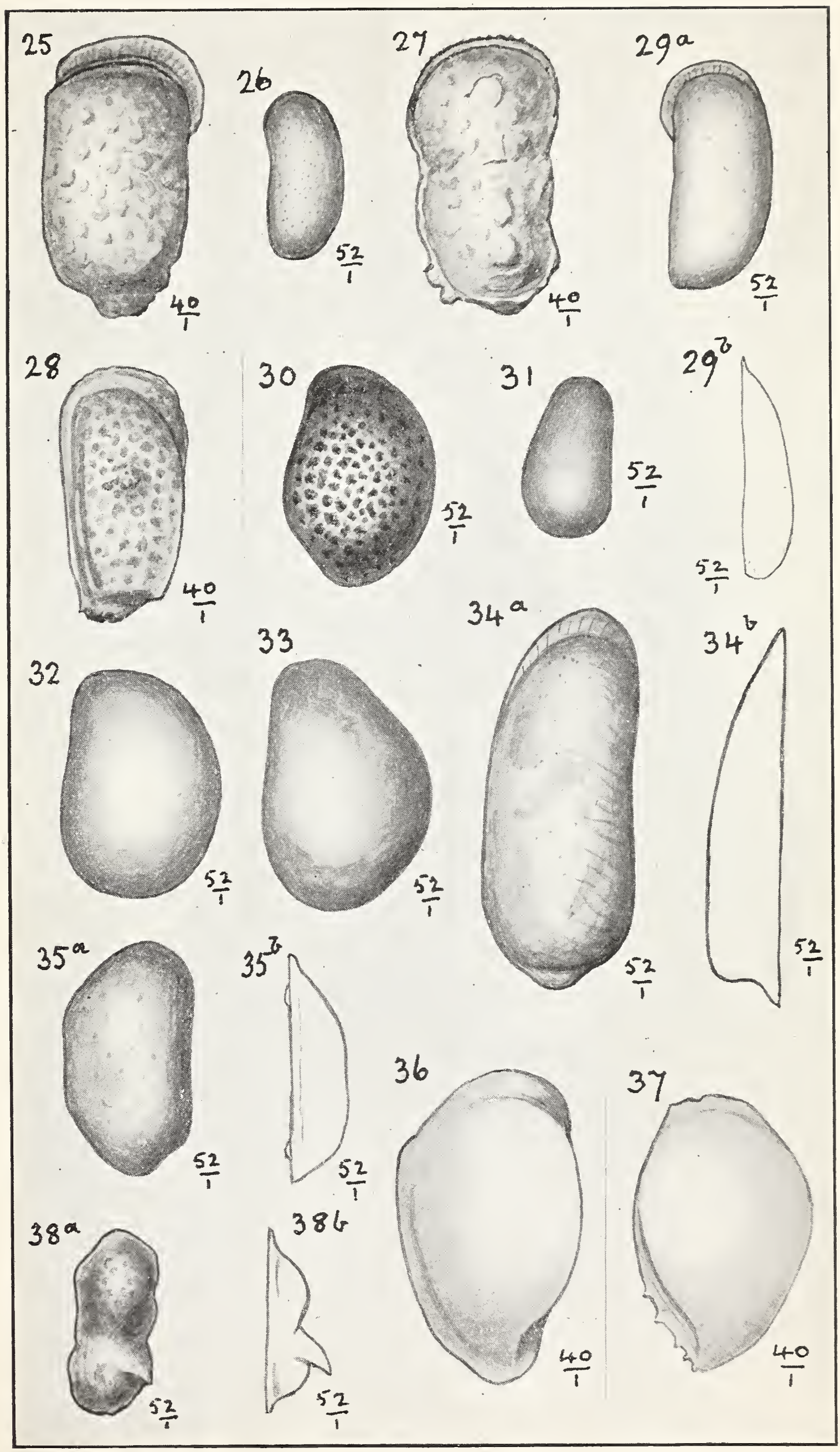
PLATE LXXIV.




F.C., ad nat. del.

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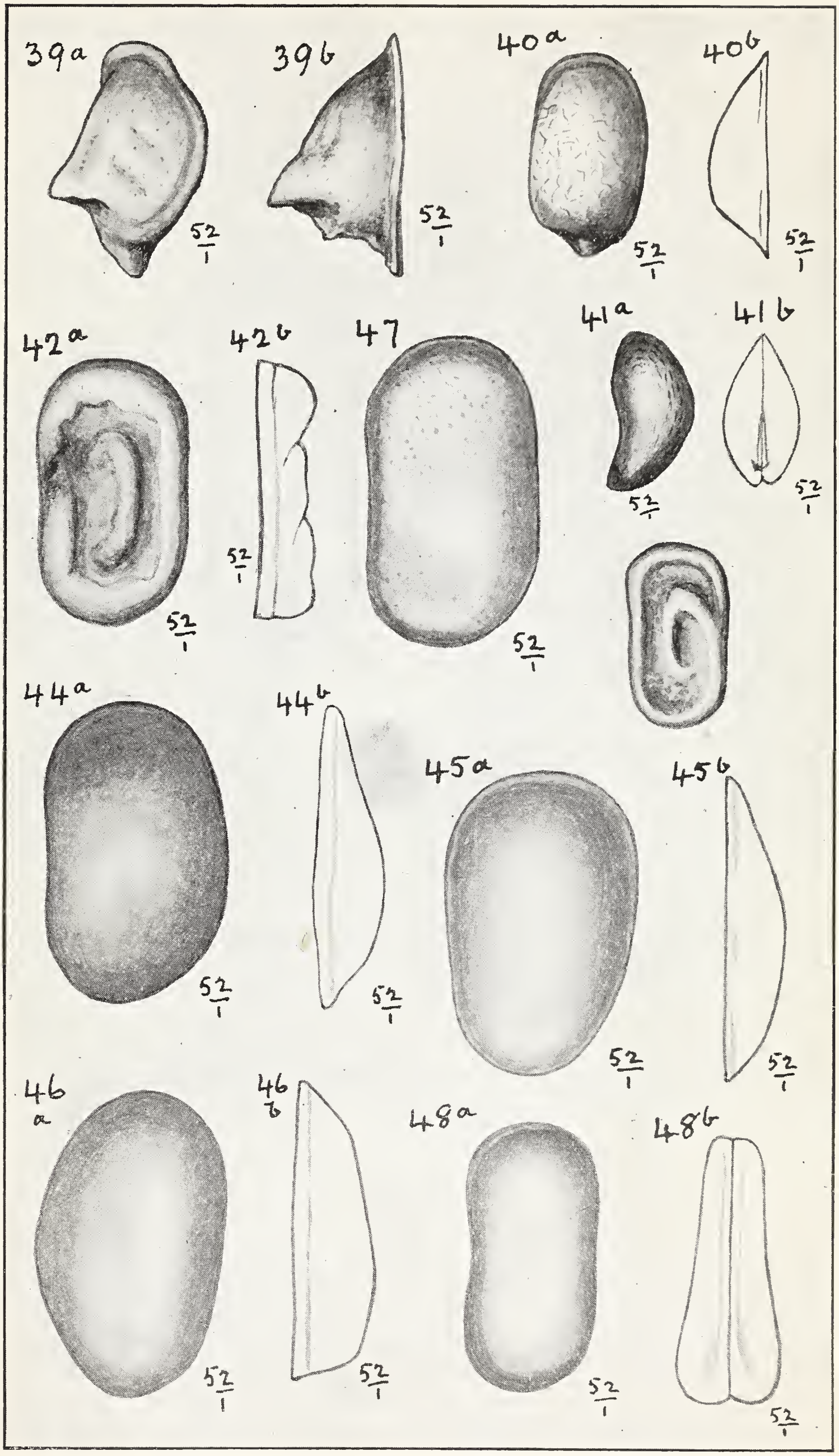
PLATE LXXV.




F C., ad nat. del.

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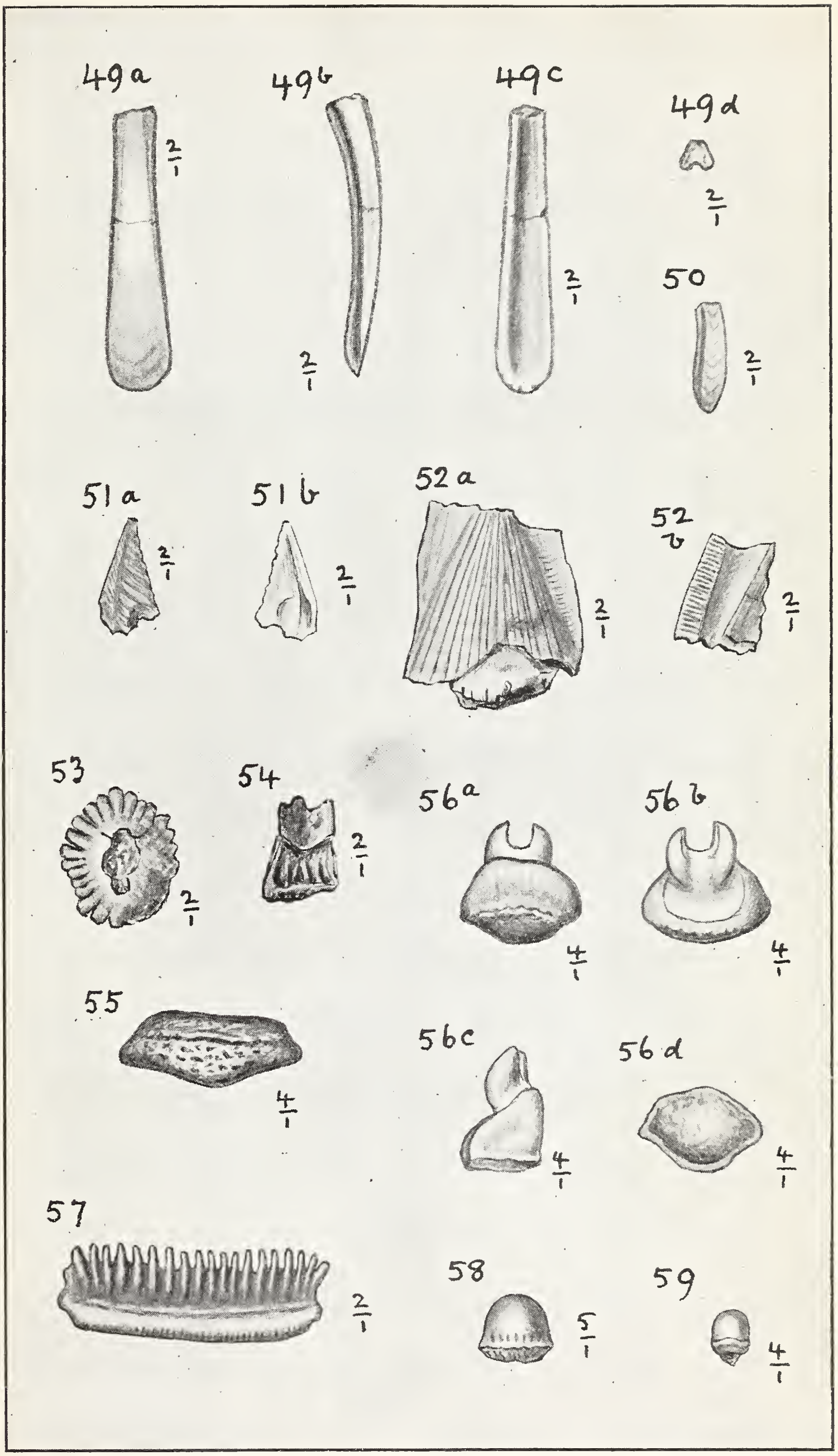
PLATE LXXVI.




F.C., ad nat. del.

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## Plate LXXVII.

Fig. 1. × 14.

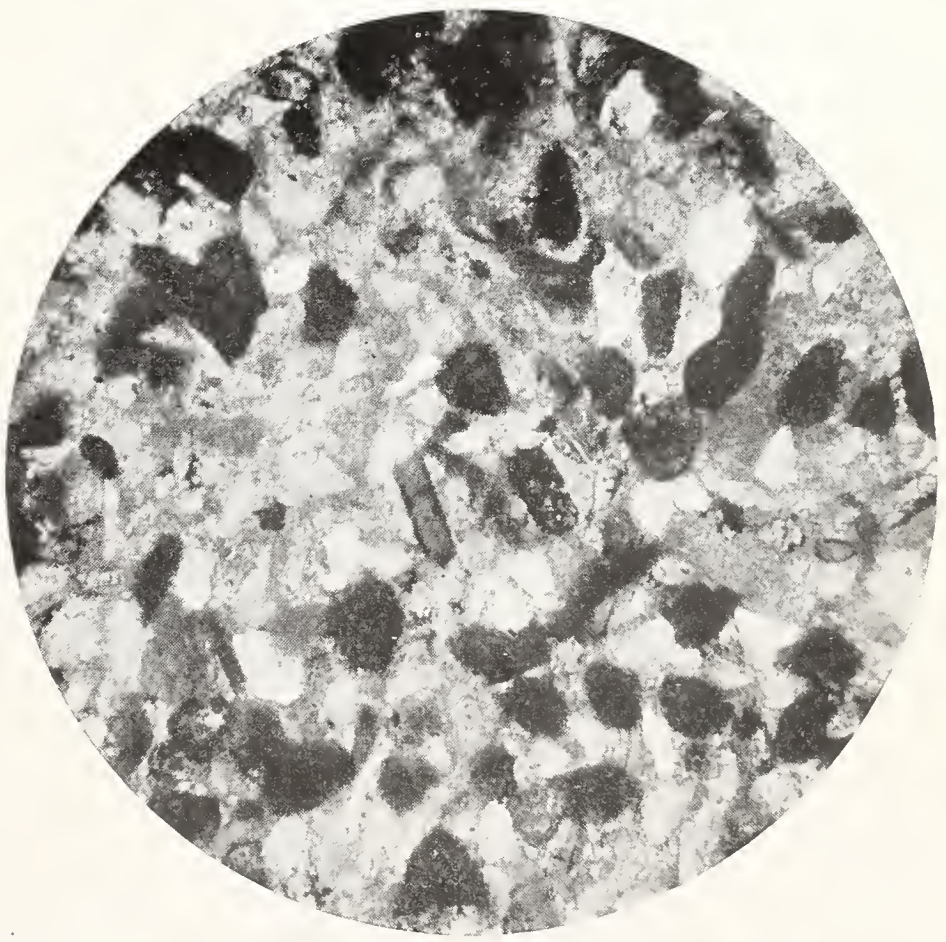

Fig. 2. × 32.
F.C., Photo.

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# Plate LXXVIII.

Ditrupa.

Fig. 1. × 32.

Orbitolites.

Fig. 2. × 14.

F.C., Photo.

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